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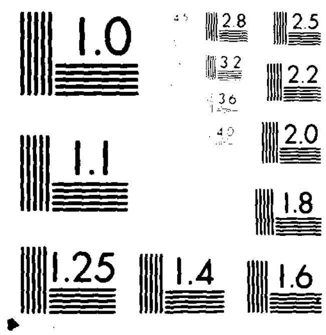

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AN ANALYSIS OF THE ACQUISITION OF
SPECIFIC ITEMS OF SUPPORT EQUIP-
MENT FOR THE F100 ENGINE

Stanley G. DeGruccio, Major, USAF
Glen A. Lindsey, Captain, USAF

LSSR 33-80

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With the acquisition of highly sophisticated weapon systems, complex Support Equipment is making a significant impact on the operational readiness and availability of major end items. This study was to analyze the acquisition and provisioning process of two specific pieces of Support Equipment associated with the Pratt and Whitney Aircraft F100 engine: the Supervisory Control System (SCS) Tester and Engine Trim Box (ETB). In addition, the Programmable Automated Trim Test System (PATTS) proposed by P&WA as a new generation item of Support Equipment was examined. The objective of this research was to evaluate the acquisition and provisioning process of two existing items of Support Equipment and compare it to an item being considered for procurement at the present time. This was done to determine if the lessons learned from the SCS Tester and ETB were being applied to PATTS. In the authors' opinions, the problems encountered with the SCS Tester and ETB were mainly due to inadequate requirements determination, improper source coding, and insufficient application of the Integrated Logistics Support concept. PATTS, though immune to many of these problems, received greater planning and coordination emphasis through the efforts and foresight of a few key individuals.

LSSR 33-80

AN ANALYSIS OF THE ACQUISITION OF SPECIFIC ITEMS OF SUPPORT EQUIPMENT FOR THE F100 ENGINE

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

By

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June 1980

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This thesis, written by

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and

Captain Glen A. Lindsey

has been accepted by the undersigned on behalf of the faculty of the School of Systems and Logistics in partial fulfillment of the requirements for the degree of

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PROBLEM STATEMENT

Historically, certain provisioning aspects for support equipment have been deficient to the point of being detrimental to the weapon system instead of being supportive of it. This judgment represents the conclusions of several studies and investigations involving support equipment acquisition. One of the more common conclusions of these studies and reports brings out a distinct lack of management emphasis on support equipment. This lack of management emphasis leads to and is compounded by a further proliferation of equipment which results in an extremely high cost and low utility rate relationship (35).

The term "Support Equipment," like many others, is a broad general category for which subdividing increases ones ability to grasp the subject. Support equipment is divided into three general categories: 1) Tools - common and special; 2) Aerospace Ground Equipment (AGE) - powered, non-powered, and vehicular; and 3) Test Measurement and Diagnostic Equipment (See Figure A-1).

This research deals with an analysis of the provisioning process of Test Measurement and Diagnostic Equipment for the F100 engine. Some initial provisioning aspects

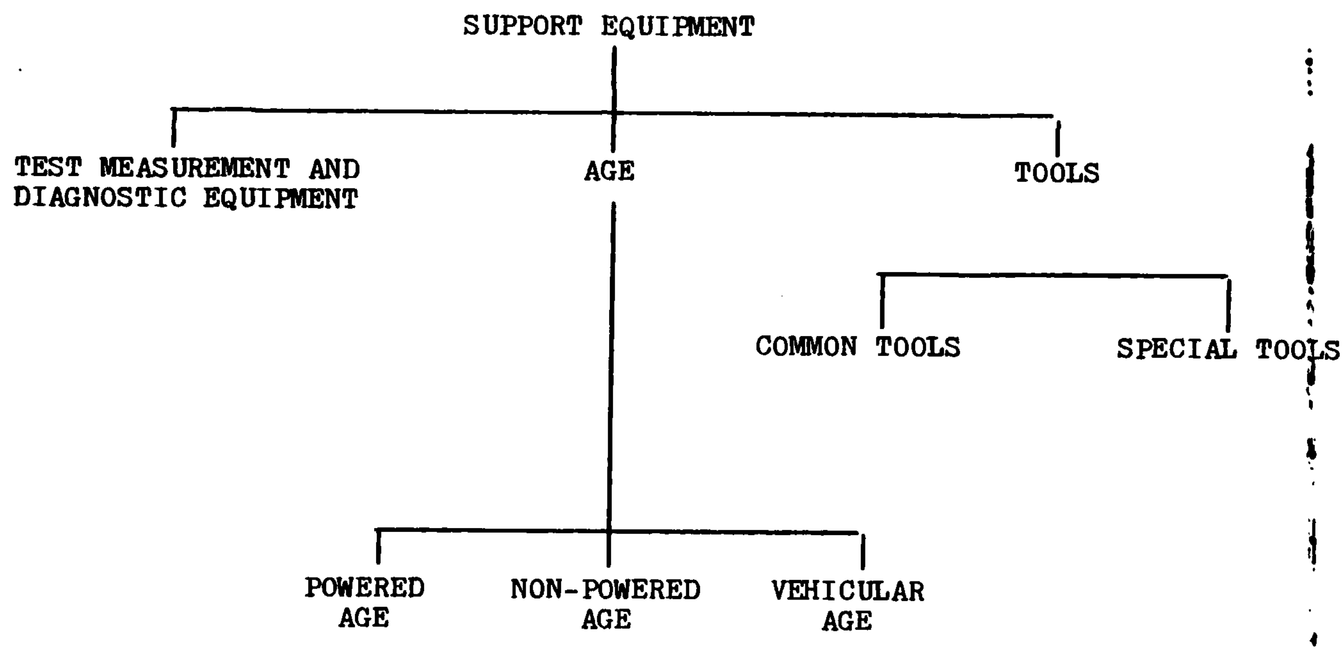

Figure A-1. Support Equipment Structure Breakdown (35).

of this equipment in support of the F100 engine have been at times deficient. This research will attempt to determine those provisioning aspects found lacking, the resultant historical effects on the operational readiness of the weapon system, and the effects on the maintenance procedures of the F100 engine. Further, an analysis will be accomplished to present provisioning procedures for support equipment being currently developed specific to the F100 engine. This will aid in determining if indeed any lessons have been learned and that the mistakes of the past are not being repeated.

DEFINITION OF TERMS

Engine Trim Box (ETB) -- (Part No. PWA 50081)

> A portable, electronic item of diagnostic equipment . . . capable of monitoring certain engine parameters. The test set is intended for use at organizational level maintenance . . . required to facilitate trimming of the Unified Control and Engine Electronic Control and to aid in diagnosing problems during trouble shooting the F100-OW-100 engine [39; 40].

Interim Contract Support (ICS) -- That support which includes all maintenance and logistical support provided by the contractor between the time of initial deployment of the item and Air Force assumption of the responsibility for support of that item.

Programmable Automatic Trim Test System (PATTS) --

> PATTS is designed for operation with the U.S. Air Force M-37 test stand and consists of a printer/keyboard, a cathode ray tube for trim instruction

and data display, and a computer programmed with the F100 trim procedures per T.O. 2J-F100-6-2. PATTS provides both consistent and accurate engine trim and also provides substantial savings in time and fuel consumption, 35% and 33%, respectively [13].

Provisioning --

> . . . is an aspect of logistics concerned with the range and quality determination and the acquisition of logical spares, repair parts, and support equipment required to maintain a hardware system during an initial period of operation [8:3].

Supervisory Control System (SCS) Tester -- (Part No. PWA 50105)

> A hand carried test set designed for use in the flight line environment experienced at the organizational maintenance level. It analyzes the electronic supervisory control (ESC) by monitoring ESC input signals while the engine is operating and compares them to previously established acceptable limits. The analysis confirms that the inputs to the ESC are nominal and that the components normally energized by the ESC output signals are operating satisfactorily [41].

Support Equipment (SE) -- ". . . those items required on the ground to make an airborne system operational in its intended environment [10:4]."

Support Equipment Recommendation Data (SERD), previously Aerospace Ground Equipment Recommendation Data (AGERD) --

> the firm recommendations of the contractor for the development . . . of support equipment. They provide detailed engineering information so that industry and the Air Force engineering and management agencies can completely understand the technical characteristics of the item requiring support, as well as the support equipment that is being recommended for development or procurement. Also included are the estimated completion dates of the first items, the estimated time to produce the items, cost, and other essential information [11:53].

LITERATURE REVIEW

Justification

With the introduction of the F-15 air superiority fighter aircraft into the Air Force inventory it became apparent that certain aspects of the provisioning process had been neglected or overlooked in the early acquisition phases.

More specifically, the F100 engine developed by Pratt & Whitney Corporation as the power plant to be incorporated into the aircraft was a state-of-the-art design. The engine was designed to be extremely efficient and by far the most powerful ever considered for an Air Force fighter aircraft. The concept was for an easily-maintainable unit requiring minimum engine removal from the aircraft (23).

During the early stages of flight-testing, problems began to arise with fuel control programming, in-flight stagnations, and afterburner blowouts. Some of the reasons for these unanticipated problems were determined to be the result of improper engine trimming and difficulties encountered with the Supervisory Control System (SCS) used to maintain the F100 engine fuel control (23; 43).

Because of these problems in the early phases of flight testing, Hamilton Standard Corporation and Howell Instruments were tasked to design and develop pieces of diagnostic test equipment to analyze these problems during

ground testing. Through a continuous evolutionary process the F100 engine and the two pieces of Support Equipment (SE) were incorporated into the overall provisioning for the F-15 and F-16 fighter aircraft as major spare items for the total systems package (43).

Support equipment, in general, has recently been the subject of numerous investigations and inspections throughout the Air Force. This increased emphasis has concentrated on the impact of SE on mission capability and overall costs. Too often there has appeared to be a significant amount of effort expended in design and development of a major system with little consideration given to the SE required to support the item on the ground (36).

In certain instances, the SE is very fragile, oversensitive to changing climatic conditions, and improperly designed to operate in a mobile military environment. In addition, as was the case with the F100 SCS Tester and Engine Trim Box (ETB), the SE items are contractor-supported, used and operated by contractor personnel, and maintained at contractor facilities (43).

Because of this Interim Contractor Support (ICS), SE is often turned over to the Air Force without adequate consideration given to the unique environment in which it must operate. As a result, a July 1978 Inspector General report pointed out that

> increased emphasis on supportability of aircraft maintenance support equipment throughout development and acquisition by Air Force Systems Command (AFSC) and Air Force Logistics Command (AFLC) would improve mission capability and reduce costs [7:5].

The Air Force, it says, is procuring items of SE that are costly to maintain, are poorly constructed, have low reliability with limited spares support, and have inadequate technical data. These common provisioning deficiencies have been generally characteristic of the support equipment area. In that the impact of these factors on field units has involved "expensive and time consuming work-around procedures to compensate for deficiencies in aircraft SE [7:6]," they will be examined in this research effort.

Due to the increased visibility and emphasis placed on SE by the AF Inspector General and the General Accounting Office (GAO), current items being considered for acquisition by the Air Force Aeronautical Systems Division (ASD) are being carefully scrutinized for supportability and maintainability. A high interest has been expressed by the Deputy Program Manager for Logistics (DPML) for the F100 engine as to the impact of these aspects on the operational capability and field deployment of the systems being considered. The question at hand is whether the Air Force is benefiting from the examples cited of the SCS Tester and Engine Trim Box, or will similar problems arise again at the expense of the using organization?

The preliminary findings of this research failed to reveal whether current and existing policy, regulations, and directives were adequate to insure support of support equipment when that equipment is consolidated into the acquisition of a major weapon system.

It has been recommended that support equipment be managed as an end item rather than as a spare, in that these equipment items are too important to be considered as high value spare parts. In addition, the suggestion that procedures be established to assure that support equipment items receive replacement analysis/business strategy consideration highlights this uncertainty (7:2).

The July, 1978 Inspector General report suggests the Support Equipment Special Project Office (SESPO) should have primary responsibility for support equipment acquisition which would enhance support equipment continuity (7:3). These IG recommendations suggest that those policies, procedures, and regulations may not be adequate and the pursuit of this question is one of high importance and worthy of considerable research effort.

Delimitation and Scope

The scope of this research was limited to a historical provisioning analysis of two presently operational pieces of support equipment - the Howell-built Engine Trim Box (ETB), and the Hamilton-built Supervisory Control System Tester

(SCST). In addition, Programmable Automatic Trim Test System (PATTS), which is currently under development, was included. These analyses consisted of historical documentation of provisioning steps made during the acquisition phase of all three pieces of equipment. Any facts brought out were related to those common provisioning deficiencies alluded to in the justification portion.

This research was designed to illustrate any provisioning deficiencies discovered during the acquisition and initial deployment phases of the ETB and SCS tester and relate those to any trend in the not-operationally-ready status of the F100 engine and any consequent effect on the weapon system. Engine maintenance records for the appropriate time period were to be analyzed to determine if those factors had any impact on normal maintenance procedures for the F100 engine. In addition, climatological factors which could possibly effect the durability and availability of the SCS Tester and ETB were to be examined.

The on-going development and acquisition of PATTS was also studied. PATTS is currently under consideration for use in the F-15 program as a state-of-the-are piece of SE. The present concept is to include an ICS type arrangement. Howell Instruments will supply, maintain, and operate the equipment at pre-selected bases throughout the world. After 31 July 1981, and successful demonstration of the hardwares capabilities, it will be offered to the Air Force under one of several options. These options include:

(a) continue no charge use of the 'PATTS' system with maintenance and spare parts provided by the USAF;
(b) lease ~~the~~ units;
(c) purchase the units at Pratt & Whitney Aircraft Group (PWAG) net book value;
(d) request that the units be removed [13].

Two of the four options previously addressed involve no risk to the USAF in terms of support. The first and third options, however, will require maintenance and support of the SE by AF personnel and supply systems. An attempt was made to determine whether or not this system is being acquired with more foresight than either the Engine Trim Box or the Supervisory Control System Tester programs.

RESEARCH OBJECTIVES

The individual objectives of this research contributed to the overall goal of indicating some of the more common reasons for improper provisioning and should have highlighted the resultant effects on the weapon systems and maintainability of the item to be supported. If the following five specific objectives could have been fulfilled, the authors believe that a major step would have been taken to further improve a situation which has a significant influence in the critical area of fiscal responsibility.

Therefore, the five objectives were to:

1) Utilize specific equipment examples (SCS Tester and Engine Trim Box) to document common provisioning deficiencies that were generally characteristic of the support equipment area.

2) Undertake an analysis of current equipment being developed (PATTS) for the F100 engine in order to indicate whether or not that equipment is being properly provisioned so as to avoid repeats of past mistakes.

3) Determine if current and existing regulations and directives are adequate to insure proper support of support equipment when consolidated into the acquisition of a major weapon system.

4) Test historical maintenance data of the F100 engine and its Support Equipment (SCS Tester and Engine Trim Box) to determine if the maintenance procedures of the engine were impacted by the non-availability of Support Equipment. This test will include analyses of correlation between unserviceability of the Support Equipment and the unscheduled maintenance on the engine.

5) Test historical maintenance data of the Support Equipment (SCS Tester and Engine Trim Box) against weather data (rainfall and temperature) to determine if the availability and failure rates of Support Equipment are affected in any way by those specific weather phenomena. This in turn would possibly indicate any possible deficiencies of the Support Equipment that would limit the items' durability and subsequent support of the weapon system.

RESEARCH QUESTIONS

Through the research process, the answering of specific questions indicated whether or not those research objectives previously stated were indeed fulfilled. The following four questions were posed to accomplish those objectives:

1) What have been some of the more common provisioning deficiencies that were characteristic in the area of support equipment as exemplified by the SCS Tester and Engine Trim Box?

2) What provisioning procedures are being presently accomplished on currently developing support equipment (PATTS) peculiar to the F100 engine that may portray any improvement in the provisioning process for support equipment?

3) Are the current and existing regulations and directives adequate to insure support of support equipment when consolidated into the acquisition of a major weapon system?

4) What were the effects of improper provisioning of specific support equipment for the F100 engine (1) on the operational readiness of the weapon system (aircraft), and (2) on maintenance procedures and schedules for the F100 engine itself?

SUMMARY

Certain provisioning aspects for support equipment have been deficient to the point of being detrimental to the weapon system instead of being supportive of it. One of the more common conclusions of several studies and investigations brings out a distinct lack of management emphasis on support equipment. This research deals with an analysis of the acquisition process of Test Measurement and Diagnostic Support Equipment for the F100 engine.

Due to problems with fuel control programming, inflight stagnations, and after-burner blowouts during early phases of flight testing, Hamilton Standard Corporation and Howell Instruments were tasked to design and develop pieces of diagnostic test equipment to analyze these problems. Among the equipment developed were the Supervisory Control System Tester and Engine Trim Box -- two of the pieces to be studied in this research effort.

The on-going development and acquisition of the Programmable Automatic Trim Test System (PATTS) was also studied to determine whether or not this system is being acquired with more foresight than either the Engine Trim Box or the Supervisory Control System Tester programs. The individual objectives of this research contributed to the overall goal of indicating some of the more common reasons for improper provisioning of Support Equipment and should

have indicated the resultant effects on the weapon systems and maintainability of the item to be supported.

Chapter 2

METHODOLOGY

Standards

In the identification of common provisioning deficiencies of support equipment, pertinent regulations and guidelines were analyzed to establish a standardized framework for that identification. The primary publications included the following:

AFR 800-12, "Acquisition of SE."

AFR 800-7, "Integrated Logistics Support Implementation Guide for DOD Systems and Equipment."

AFR 800-8, "ILS Program for Systems and Equipment."

AFR 800-21, "ICS for Systems and Equipment."

AFSCR/AFLCR 800-5, "Age Acquisition Management."

AFSCR/AFLCR 800-24, "Standard Integrated Support Management System."

AFLCR 65-6, "Air Force Provisioning Policies and Procedures."

AFAD 71-685, "Age Identification/Selection/Acquisition/Provisioning for USAF Contracts."

This standardized framework was utilized in the comparison of historical data to include all original provisioning documents of the specific units of equipment previously

described. Further, reports and analyses compiled by outside sources were drawn from to provide a broad foundation for the presentation and validation of these common deficiencies.

These reports and analyses included Air Force Inspector General and General Accounting Office (GAO) reports which recently dealt with support equipment problems in general and indicated overall areas for improvement. These reports and pertinent official Air Force and MAJCOM publications were combined to form a set of criteria with which to form a basis for an impartial comparison and analysis of the initial provisioning processes as they occurred for the SCS Tester and Engine Trim Box.

Present provisioning processes in the acquisition of the Programmable Automatic Trim Test Set (PATTS) were analyzed and presented. The study of PATTS will indicate whether equipment being presently developed for the F100 engine is being properly acquired so as to avoid repeats of past mistakes. This will hopefully indicate that at least some of the lessons of the past have been learned and that increased and much needed emphasis is being given to the support of support equipment.

Data Collection Plan

A detailed analysis of the initial F100 contract (F33657-70-C-0600), Aerospace Ground Equipment Recommendation

Data (SERD) documents for the SCS Tester and Engine Trim Box was accomplished. This was presented in order to establish the original provisioning concepts designed under the initial purchase of both pieces of equipment.

The Unsolicited Proposal for PATTS along with other initial acquisition documents were evaluated. Personal interviews with those individuals actively involved in the acquisition of this piece of support equipment were necessarily included. This aspect of the research process was considered to be among the most critical and important areas that the investigators could pursue.

In-depth interviews of all available personnel who were involved with the initial acquisition of both the SCS Tester and Engine Trim Box were included. Personnel involved with the operational use of the equipment provided inputs with the expressed intent of the authors to document actual hands-on experience with each piece of equipment. These interviews, with the data they provided, along with official publications and equipment acquisition documents provided the basis for conclusions drawn from this research.

In order to present the proper and most pertinent questions and weigh correctly those aspects used in acquisition of the data, expert guidance was obtained in the formulation of the interview guides (43). The intent was to place in proper perspective any information obtained from the interview in order to control any possible bias on the

part of the interviewers (See Appendix Interview Guides). The variations of the guides involved the specific piece of equipment -- SCS Tester, Engine Trim Box, or PATTS; and area of involvement of the interviewee -- acquisition or maintenance.

The reader is cautioned at this point against any overgeneralization in studies of this type. Case studies of these specific pieces of equipment determined only relevant historical facts pertaining to that equipment. It was the authors' desires and objectives to portray the provisioning processes involved with the SCS Tester, Engine Trim Box, and PATTS as examples of the support for Support Equipment.

Each phase in the provisioning process studied was related to the equipment under consideration and support equipment in general. Attempts were made to point out both good and bad examples of the provisioning process and relate those examples to the Support Equipment arena in as logical a plan as possible. It is acknowledged that any type of support equipment may have peculiar characteristics in its provisioning requirements. These were indicated so as to minimize any generalization which would not be valid.

All data utilized in this study were taken from official Air Force and government documents and industrial inputs from the various manufacturers. Opinions taken from the interviews were treated as such, but were used in the formulation of conclusions and recommendations based on the expertise of those involved.

DESIGN TO ANSWER RESEARCH QUESTION NO. 4

As stated in objectives number four and five of this research effort, it was the intent of the authors to show the effects of improper provisioning of specific items of support equipment for the F100 engine on the operational readiness of the weapon system, and on the maintenance procedures and schedules for the engine itself. Due to factors to be enumerated in Chapter 4 (Analysis), this statistical effort could not be accomplished in this research effort. The design and methodology, however, are included to facilitate future studies in this direction.

Numerical data pertaining to the F100 engine were provided by the Miscellaneous Engine and Data Section (MMPRR-B3), Directorate of Materiel Management, Kelly AFB Tx. Data pertaining to the maintenance history of the SCS Tester and Engine Trim Box were to be obtained from the Aerospace Guidance and Metrology Center's (AGMC) Precision Measurement Laboratories (PMEL) at Langley AFB, VA, and Luke AFB, Az. AGMC's LOG 20 (Precision Measuring Equipment Calibration Interval) report was also to be utilized for summarized data.

Weather data were obtained from the weather squadrons at Luke AFB, Az. and Langley AFB, Va. The data were to be taken from the time period between November 1974 and December 1979, inclusive, on a month-by-month correlation for input into the various regression analyses involved.

Definition of Variables

1. Unscheduled Engine Removals (UER) -- Those engine removals per 1000 flying hours per month which were accomplished as a result of unforeseen circumstances. Those circumstances include varying factors, but the factor under consideration in this report was to deal with the unserviceability of the engine support equipment as it impacted on the maintenance of the engine. That engine maintenance necessarily includes engine removal -- both scheduled and unscheduled -- and any factor necessitating an unscheduled engine removal should be worthy of consideration due to the high expense involved and the decreased state of operational readiness of the weapon system caused by that factor.

2. Total Failures Per Month (TFPM) -- Those combined failure rates (for whatever reason) of the SCS Testers and Engine Trim Boxes, per month. The reader must be made aware that each failure may result in differing lengths of unserviceability -- some short, some long -- and this variable of interest (TFPM) expresses only the overall quantity of unit failures exclusive of the cause or length of subsequent unserviceability.

3. Equipment-Days Unserviceable Per Month (EDUPM) -- Those combined days of unserviceability of the SCS Testers and Engine Trim Boxes which were to be the result of failures of the test equipment addressed in # 2 above. This unserviceability rate was to be calculated by accumulating the

total days each piece of equipment was unserviceable as indicated by maintenance records, and presenting these individual figures in an overall sum of unserviceability.

4. Mean Precipitation Per Month (MPPM) -- the mean precipitation was to be calculated by utilizing the figures provided by the weather squadrons from Luke AFB AZ and Langley AFB Va, the sites of initial deployment of the test equipment. Total monthly figures from both locations were to be combined and a mean was to be used to test any relationship between precipitation rates and unserviceability of equipment.

5. Mean Temperature Per Month (MTPM) -- the mean monthly temperature of the readings from the weather squadrons from Langley AFB VA and Luke AFB AZ. This statistic, although potentially less effective on the serviceability than mean precipitation, was felt to possibly have some effect on the operation of the equipment and its testing would have been justified.

Research Hypotheses

The following six hypotheses were to be tested in order to adequately address research objectives four and five:

1. Unscheduled Engine Removals (UER), the dependent variable, is correlated to Total Failures per Month (TFPM) of the Support Equipment. A relatively high degree of

correlation would demonstrate the importance of the reliability of Support Equipment on the maintenance procedures of the weapon system it supports.

2. Unscheduled Engine Removals (UER), the dependent variable, is correlated to Equipment Days Unserviceable per Month (EDUPM) and Total Failures per Month (TFPM) of the Support Equipment, the independent variables. Any degree of multiple correlation exhibited in this test would further substantiate the effect of Support Equipment on maintenance procedures of the weapon system it supports.

3. Total Failures per Month (TFPM), the dependent variable, is correlated to the Mean Precipitation per Month (MPPM), the independent variable. A high degree of correlation between these two variables would indicate the all-weather specifications of the Support Equipment had not been met.

4. Total Failures per month (TFPM), the dependent variable, is correlated to Mean Precipitation per Month (MPPM) and Mean Temperature per Month (MTPM), the independent variables. A high degree of correlation here would further substantiate a possible design deficiency as indicated in # 3 above.

5. Unscheduled Engine Removals (UER), the dependent variable, is correlated to Mean Precipitation per Month (MPPM), the independent variable. This would exhibit the transitive characteristic that could possibly indicate any

design deficiency of the Support Equipment adversely affecting the operational readiness of the weapon system.

6. Unscheduled Engine Removals (UER), the dependent variable, is correlated to both Mean Precipitation per Month (MPPM) and Mean Temperature per Month (MTPM), the independent variables. This multiple correlation would further establish those transitive effects of unserviceable Support Equipment (caused by climatic conditions) on the operational readiness of the weapon system.

Statistical Methodology

Engine data to be used in this study was to be from November 1974 through December 1979, divided into monthly segments. This data was to provide the UER rate per 1000 hours of flying time per month. The data used for support equipment was to cover a similar time period and is expressed by EDUPM and TFPM. Any relationships between the aforementioned data elements was to be determined through simple linear and multiple regression techniques. In addition, any relationship between TFPM, TPPM and MTPM was to be determined by similar procedures to draw inferences concerning the correlation between climatic conditions and breakdown trends of the pieces of SE being studied. These procedures were to form the basis for conclusions and predictions with regards to the level of relativity between supply support systems for support equipment items designed to provide easy, in-place engine diagnosis and the availability and

reliability of those items. The other area to be investigated involved a test of correlation between possible design deficiencies of that equipment when exposed to the climatic characteristics encountered during field level and organizational usage.

Initial tests were to involve a simple linear regression analysis to determine whether or not a relationship between UER and TFPM exists. By the use of the SIMFIT/MULREG computer package a coefficient of determination (R^2) was to be obtained to describe the degree of this relationship. In other words, how much of the variability in UER was reduced when the independent variable TFPM was considered? If the proportionate reduction of TFPM was significant, then the regression made would have been highly useful in further analysis. In addition, a plot of the residuals was to be analyzed to determine the aptness of the linear regression model.

If the coefficient of determination (R^2) was considered significant and the residual analysis reflected the properties of the error terms (normal random variables with constant variance) then a test of whether or not a relation between UER and TFPM exists was to be conducted. The alternatives for this test were to be:

H_0: $\beta_1 = 0$ - that UER and TFPM were not related

H_1: $\beta_1 \neq 0$ - that UER and TFPM were related

the appropriate decision rule for this test when controlling the α risk at .10 was:

If $F^* \leq F\,(.90;\ n-2)$, conclude H_o

If $F^* > F\,(.90;\ n-2)$, conclude H_1

where F^* was obtained from the computer package SIMFIT/MULREG.

Subsequent analyses was to involve a multiple regression procedure to test UER and both independent variables - TFPM and EDUPM. The first thing evaluated would have been the adjusted coefficient of determination (R_a^2). Since the addition of independent variables is not recognized in the original R^2 value, it was felt that the adjusted value would have been more meaningful and better reflect the reduction in variability of UER with the introduction of the independent variables EDUPM and TFPM. Next to be considered would have been the variable coefficient for TFPM (b_1). If there were no substantial change in this value, then the problem associated with multicollinearity could have been ignored. If multicollinearity were to be discovered and a high correlation between TFPM and EDUPM did exist, further attempts to make inferences about the relationship between UER, EDUPM and TFPM would have been aborted.

Assuming there was no significant correlation between the independent variables, EDUPM and TFPM, then further obtained analysis of the multiple regression model would have been pursued. This analysis would have included an

evaluation of the variable coefficient (b_1 and b_2) to determine the extent to which each was related to UER and a determination of which was the more significant.

The preceeding analyses were to have been primarily concerned with the relationship between the availability of SE and the abnormal maintenance procedures utilized on the F100 engine. The next point of interest was to be the possible design deficiencies which might have contributed to the availability of critical pieces of SE. To make certain inferences about the effects of climatic conditions on the reliability of the pieces of SE being investigated a test of the relationship between TFPM, MPPM, and MPTM was to be conducted.

As was to be accomplished in the case of UER and TFPM, a simple linear regression analysis would initially be attempted to determine whether or not a relationship between TFPM (dependent variable) and MPPM (independent variable) existed. Again, R^2 was to be evaluated to determine the degree of variability in TFPM reduced by the introduction of the variable MPPM. A plot of residuals was to be made and analyzed to see if the regression model was appropriate.

If the coefficient of determination (R^2) and the plot of residuals revealed the necessary characteristics of the regression model, the test previously described would

have been made to determine whether or not a relationship existed between TFPM and MPPM and to what extent. The alternatives for this test were to be:

H_0: $\beta_1 = 0$ - that TFPM and MPPM were not related

H_1: $\beta_1 \neq 0$ - that TFPM and MPPM were related

the decision rule for this test when controlling the α risk at .10 was to be the same as stated in the test for UER and EDUPM.

To further investigate the impact of climatic conditions on availability and reliability of SE, a multiple regression analysis was to be conducted on TFPM as the dependent variable and MPPM and MTPM as independent variables. Following the same procedures utilized in the preceeding multiple regression analysis, the adjusted coefficient of determination (R_a^2) and the variable coefficients (b_1 and b_2) would have been closely scrutinized to determine if a relationship between TFPM, MPPM, and MTPM existed. The variable coefficient (b_1) for MPPM would have been observed for any substantial change which would have indicated a high degree of correlation in the independent variables.

Finally, in an effort to draw some sort of firm conclusion with regards to the relationship of maintenance practices (UER) and SE reliability, a comparison of climatic conditions to UER would have been conducted. The reason for this scenario was to limit or reduce the impact of outside influences on the relationships (if any), discovered in this

study. It was felt that if a relationship between UER, MPPM, and MTPM were to exist in the same proportionate amounts as that of TFPM to MPPM and MTPM, then conclusions to the effects of SE reliability on maintenance practices could have been drawn with a reasonable degree of certainty.

The procedures used for the comparison of UER to MPPM and MTPM would have been identical to those used in the previous two tests. The alternatives for the test of relationship between UER and MPPM, however, would have been:

H_0: $\beta_1 = 0$ - that UER and MPPM are not related

H_1: $\beta_1 \neq 0$ - that UER and MPPM are related

the decision rule in this test to control the α risk at .10 was to be the same as used in the previous two simple regression tests. Any conclusions, predictions, and generalizations made from these comparisons would have been put into their proper perspective with regards to all the test findings and relationships discovered.

At this point, the authors feel it necessary to point out the limitations of the tests which were to be performed on the proposed data for this study. It must be understood that certain qualitative factors (personnel, supply, procedures, etc.) which were beyond the scope of this study and regression analysis procedures would have impacted on both the dependent (UER and TFPM) and independent variables (EDUPM, MPPM, and MTPM) to be utilized. For this reason, no attempt would have been made to incorporate these

factors into the analyses performed and should be the subject of additional independent research efforts concerning SE and its relationship to operational readiness of weapon systems.

SUMMARY

In the identification of common provisioning deficiencies of Support Equipment, all pertinent regulations were analyzed to establish a standardized framework for that identification. Further, reports and analyses compiled by outside sources were drawn from to provide a broad foundation for the presentation and validation of these common deficiencies, in addition to the original contracts, Support Equipment Recommendation Data (SERD), and other acquisition documents specific to the pieces of equipment of interest.

Personal interviews, with the data they provided, along with the official publications and equipment acquisition documents formed the basis for answering one of the most important research questions of this effort.

Data pertaining to the F100 engine were provided by the Miscellaneous Engine and Data Section (MMPRR-B3), Directorate of Materiel Management, Kelly AFB, Tx. Weather data were provided by the weather squadrons at Luke AFB, Tz. and Langley AFB, Va. from the time period between November 1974 and December 1979, inclusive, on a month-by-month correlation for input into the various regression analyses involved.

Data pertaining to the maintenance history of the pieces of Support Equipment involved were to be obtained from AGMC's Precision Measurement Equipment Laboratories at Langley AFB, Va. and Luke AFB, Az., with summarized data to be provided by the LOG 20 (Precision Measuring Equipment Calibration Interval) report.

These three groups of data were to be analyzed via multiple regression techniques to illustrate the effects of improper provisioning of specific items of Support Equipment for the F100 engine on the operational readiness of the weapon system, and on the maintenance procedures and schedules for the engine itself. Due to factors to be explained in the next chapter, this could not be accomplished. The statistical methodology, however, is provided to facilitate future studies in this direction.

Chapter 3

INTRODUCTION

This chapter chronologically portrays the events and occurrences associated with the acquisition and provisioning of the Supervisory Control System (SCS) Tester, Engine Trim Box (ETB), and Programmable Automatic Trim Test System (PATTS).

Due to the extensive time lapse since many of these events, coupled with changes in personnel and office reorganizations, the availability of hard copy documentation was extremely limited and in some cases non-existent. The authors feel, however, that the available records, messages, and letters along with numerous interviews conducted with personnel directly and indirectly associated with the acquisition and provisioning processes allows a valid representation of the occurrences as they took place. Though some inferences were necessary, it is felt that the information presented in the following pages is reasonably accurate and significantly contributes to this research effort.

DEFINITION OF TERMS

Calibration Requirements Summary (CRS) --

> is a four-part summary of the technical measurement requirements of a system/end article which outline the technical requirements of parameters at each echelon of measurement [8:41-3].

Initial Spares Support Test (ISSL) --

A list of spares and repair parts and quantities required for organizational and field maintenance initial support of an end item for a given period of time [9].

Integrated Logistic Support (ILS) --

the definition, optimization, and integration achieved by systematic planning, implementation, and management of logistic support resources throughout the system life cycle [51:II-1].

Physical Configuration Audit (PCA) --

the formal examination of the 'as-built' configuration of a unit of CI against its technical documentation in order to establish the CI's initial configuration identification [48].

Recoverable Item Breakdown (RIB), previously Provisioning Parts Breakdown (PPB) --

the breakdown for recoverable type items which is an all inclusive breakdown and used for support item selection and assignment of technical and management codes [8:9-1].

CHRONOLOGICAL EVENTS

Acquisition Phase

On 1 March 1970, AFSC Aeronautical Systems Division (ASD) awarded a contract to United Aircraft Corporation/ Pratt and Whitney Aircraft Division, West Palm Beach, Florida to

> . . . continue the design and/or redesign of the engine systems . . . necessary to complete the Category I development of the F100-PW-100 engine . . . Fabricate and/or procure parts, assemble, inspect, acceptance test, deliver YF100-PW-100 engines to support the F-15 Category I flight tests . . . . Fabricate and/or procure parts, assemble, inspect,

> acceptance test, and deliver F100-PW-100 production engines . . . to support the F-15 operational first wing aircraft [2].

In addition, item number four (4) of that same document specified

> Aerospace Ground Equipment (AGE) to support the engines . . . to be selected and furnished in accordance with AFPI 71-685 entitled "Aerospace Ground Equipment Identification/Selection/Acquisition/Provisioning Document for USAF Contracts," dated April 1966 and Amendment #1 thereto dated June 1967, both of which are hereby incorporated herein by reference . . . [2].

As a result of the requirements outlined in the prime contract (F33657-70-C-0600) with regards to AGE, Aerospace Ground Equipment Recommendation Data (AGERD) numbers 1031 (Test Set, Engine Trim - PWA 50103), 1032 (Test Set - PWA 50104), and 1033 (SCS Tester - PWA 50105) were submitted by Pratt and Whitney Aircraft Division (P&WA) to AFSC/ASD on 26 May 1972. These AGERDs proposed engine diagnostic equipment considered necessary at the organizational maintenance level to: monitor engine conditions while trimming the F100 engine; monitor engine parameters when analyzing abnormal engine conditions or establishing performance trends; and analyze the inputs/outputs of the electronic supervisory control (ESC), respectively.

In July 1972, the Propulsion and Power Branch/ASD approved each AGERD for Category I testing only. The limitation was required due to insufficient data to adequately review the AGERD items for operational use (14). That same

month the Weapons System Development Division/HQ TAC responded by withholding approval pending more definitive information (24). In August 1972, the Jet Engine Propulsion Office Engineering Division acknowledged the need for ground support equipment to perform the functions identified in the subject AGERDs. Again, however, they pointed out that insufficient information was provided in the documents to determine the suitability of the proposed hardware (33).

In each of these incidents the information requested or identified as lacking in the documents was concerned with engine parameters and airframe compatability requirements. Each agency felt it necessary to withhold final approval pending submission of additional data which would clarify the purpose and proposed usefulness of the recommended equipment. In order to facilitate the coordination and communication of these requirements a meeting with the System Project Office (SPO) and P&WA was recommended.

While these AGERD deficiencies were being identified and surfaced, the Aerospace Guidance and Metrology Center (AGMC), the San Antonio Air Logistics Center (SA-ALC) Item Manager, and HQ AFLC were simultaneously taking action and initiating coordination efforts on the proposed support equipment. For example, the Item Manager (IM) at SA-ALC extracted data from the AGERD (Figures C-1, C-2, C-3) in order to initiate the AFLC Form 323A, Requirements Data Worksheet. With this information he alerted both the

AEROSPACE GROUND EQUIPMENT RECOMMENDATION DATA			DATE	DOC NO	PAGE NO.
			24 APRIL 72	3	4
MODEL DESIG. AND NAME OF END ARTICLE	CONTRACTOR	CONTRACT NO	QUANTITY	REV NO	CROSS INDEX
F100-OW-100 TURBOFAN ENGINE	PRATT & WHITNEY AIRCRAFT	F33657-70-C-0600		ORIGINAL	NONE
NOMENCLATURE				CALIBRATION	CRITICAL
TEST SET - ENGINE TRIM					Eng. Proc.

ITEM NO.	SYSTEM AREA INDEX	WORD DESCRIPTION	AGE INDEX	FEDERAL STOCK NUMBER FSC	FIIN	FED. MANUFACTURERS CODE PART OR DRAWING NO.		MATCH CODE
1031				4920	+	77445	PWA 50103	
STATUS CODE	RESPONSIBLE AGENCY	PROPOSED SOURCE	EST. DATE 1ST ARTICLE	EST. PROD. LEAD TIME	DATE OF APPROVAL	DATE REQUIRED	DEV. COST (est.)	END ITEM EFF.
	ASD	CPE	14 MONTHS	6 MO ARO		1 FEB 1972		Y/F

THIS TEST SET IS CONTROLLED BY SPECIFICATION CP11186

\+ NOT AVAILABLE AT THIS TIME
** THE DEVELOPMENT COST ASSOCIATED WITH OPERATIONAL PROGRAM REQUIREMENTS IS NOT INCLUDED IN THE UNIT COST. THE QUALIFICATION AND OTHER TEST/DOCUMENT COSTS ARE UNKNOWN AT THIS TIME.
* UNIT COST OF THE OPERATIONAL PROGRAM EQUIPMENT IS BASED ON AN ORDER OF 1 TO 5 UNITS.

CAT I AND CAT II

MCAIR	ORG	INTER	TRAINING	OVERHAUL	TOTAL
1	1	1	0	0	3

F401 ITEM NO. 1217

ORGANIZATIONAL REQUIREMENTS							FACILITY REQUIREMENTS	TOTAL RECOMMENDED QTY.	UNIT COST (est.)	TOTAL ON ORDER	TOTAL COST (est.)
USE			ORG	INT	O/H	MTS	NOT APPLICABLE	CAT I & II	CAT I & II	CAT I & II	CAT I & II
NO.								3	$12,000 E	+	$36,000 E
B/I			2	0	0	0		OPERATIONAL	OPERATIONAL	OPERATIONAL	OPERATIONAL
TOTAL								TBD	$12,000 E *	+	+

Figure C-1 Aerospace Ground Equipment Recommendation Data (39).

AEROSPACE GROUND EQUIPMENT RECOMMENDATION DATA

AEROSPACE GROUND EQUIPMENT RECOMMENDATION DATA			DATE: 24 APRIL 72	DOC NO: 3	PAGE NO.: 5
MODEL DESIG. AND NAME OF END ARTICLE: F100-PW-100 TURBOFAN ENGINE	CONTRACTOR: PRATT & WHITNEY AIRCRAFT	CONTRACT NO: F33657-70-C-0600	QUANTITY:	REV NO: A	CROSS INDEX: NONE
NOMENCLATURE: TEST SET-VIBRATION, PRESSURE, TEMPERATURE, VANE POSITION				CALIBRATION: X	CRITICAL: Eng. Proc.

ITEM NO.	SYSTEM AREA INDEX	WORD DESCRIPTION	AGE INDEX	FEDERAL STOCK NUMBER FSC	FEDERAL STOCK NUMBER FIIN	FED. MANUFACTURERS CODE PART OR DRAWING NO.		MATCH CODE
1032				4920		77445 PWA 50104		
STATUS CODE	**RESPONSIBLE AGENCY**	**PROPOSED SOURCE**	**EST. DATE 1ST ARTICLE**	**EST. PROD. LEAD TIME**	**DATE OF APPROVAL**	**DATE REQUIRED**	**DEV. COST (est.)**	**END ITEM EFF.**
	ASD	CFE	14 MONTHS	7 MOS ARO		1 FEB 1972	**	Y/F.

THIS TEST SET IS CONTROLLED BY SPECIFICATION CP11187

\+ NOT AVAILABLE AT THIS TIME
** DEVELOPMENT COST ASSOCIATED WITH OPERATIONAL PROGRAM REQUIREMENTS IS NOT INCLUDED IN THE UNIT COST. THE DRAWING AND OTHER DOCUMENTATION COSTS ARE UNKNOWN AT THIS TIME.
* UNIT COST OF THE OPERATIONAL PROGRAM IS BASED ON AN ORDER OF 3.

(A) NOTE: REVISION "A" CANCELS PWA 50104

CAT I AND CAT II

MCAIR	ORG	INTER	TRAINING	OVERHAUL	TOTAL	1218 F401 ITEM NO.
1	2	0	0	0	3	

ORGANIZATIONAL REQUIREMENTS							FACILITY REQUIREMENTS	TOTAL RECOMMENDED QTY.	UNIT COST (est.)	TOTAL ON ORDER	TOTAL COST (est.)
USE			ORG	INT	O/H	MTS	NOT APPLICABLE	CAT I & II	CAT I & II	CAT I & II	CAT I & II
NO.								3	$67,500 E	+	$202,500 E
B/I			1	0	0	0		OPERATIONAL	OPERATIONAL	OPERATIONAL	OPERATIONAL
TOTAL								TBD	$67,500 E *	+	+

Figure C-2 Aerospace Ground Equipment Recommendation Data (40).

AEROSPACE GROUND EQUIPMENT RECOMMENDATION DATA

MODEL DESIG. AND NAME OF END ARTICLE	CONTRACTOR	CONTRACT NO	DATE	DOC NO	PAGE NO.
P100-PW-100 TURBOFAN ENGINE	PRATT & WHITNEY AIRCRAFT	F33657-70-C-0600	24 APRIL 1972	3	4
			QUANTITY	REV NO	CROSS INDEX
				ORIGINAL	NONE
NOMENCLATURE				CALIBRATION	CRITICAL
TEST SET - SUPERVISORY CONTROL SYSTEM					Eng. Proc.

ITEM NO.	SYSTEM AREA INDEX	WORD DESCRIPTION		AGE INDEX	FEDERAL STOCK NUMBER FSC	FIIN	FED. MANUFACTURERS CODE PART OR DRAWING NO.		MATCH CODE
1033					4920	+	77445 FWA 50105		
STATUS CODE	RESPONSIBLE AGENCY	PROPOSED SOURCE	EST. DATE 1ST ARTICLE		EST. PROD. LEAD TIME	DATE OF APPROVAL	DATE REQUIRED	DEV. COST (est.)	END ITEM EFF.
	ASD	CPE	14 MONTHS		6 MO ARO		1 FEB 1972	**	Y/F

THIS TEST SET IS CONTROLLED BY SPECIFICATION CP "TBD"

+ NOT AVAILABLE AT THIS TIME
** DEVELOPMENT COST ASSOCIATED WITH OPERATIONAL PROGRAM DOCUMENTATION REQUIREMENTS IS NOT INCLUDED IN THE UNIT COST AND ARE UNKNOWN AT THIS TIME.
* UNIT COST OF THE OPERATIONAL PROGRAM EQUIPMENT IS BASED ON AN ORDER OF 1 TO 5 UNITS.

CAT I AND CAT II

MCAIR	ORG	INTER	TRAINING	OVERHAUL	TOTAL
1	1	1	0	0	3

F401 ITEM NO. 1219

ORGANIZATIONAL REQUIREMENTS							FACILITY REQUIREMENTS	TOTAL RECOMMENDED QTY.	UNIT COST (est.)	TOTAL ON ORDER	TOTAL COST (est.)
USE			ORG	INT	O/H	MTS	NOT APPLICABLE	CAT I & II	CAT I & II	CAT I & II	CAT I & II
NO.								3	$22,000 E	3	$66,000 E
B/I			1	0	0	0		OPERATIONAL	OPERATIONAL	OPERATIONAL	OPERATIONAL
TOTAL								TBD	$22,000 E	+	+

Figure C-3 Aerospace Ground Equipment Recommendation Data (41).

responsible Provisioning Officer and Inventory Manager of the pending acquisition (44).

In September 1972, the Equipment Specialist/ILS Directorate consolidated the inputs and requirements of the three agencies mentioned above and submitted them in the form of a matrix formatted checklist (Figure C-4). For each AGERD he identified the need for calibration procedures, Technical Order data, and Provisioning Parts Breakdown (PPB). The details and specifications, however, of these requirements were not included in the matrix format provided and the extent to which they were to be coordinated was left unaddressed (56).

On 18 August 1972, AGERDs 1031, and 1033 were conditionally approved by the Support Equipment Engineering Division pending satisfactory completion of technical design reviews and field service testing of the unit. Also required prior to final approval was submission of a Calibration Requirements Summary (CRS), Technical Order (T.O.), and PPB data (46). On 8 December of that same year P&WA provided an implementation schedule and plan for evaluating the usefulness and adequacy of the recommended diagnostic equipment (Figure C-5). On 10 August 1973, final approval for all three AGERDs was received. The requirements, however, for a CRS, T.O., and PPB data were again addressed and identified as needed for the subject support equipment items (29).

AGERD #	APPR	DIS-APPR	CAL REQ'D YES	CAL REQ'D NO	FED STD 5 YES	FED STD 5 NO	T.O. REQ'D YES	T.O. REQ'D NO	AGEI REQ'D YES	AGEI REQ'D NO	PPB REQ'D YES	PPB REQ'D NO	DATA DEFER
0115A	x			x		x		x		x		x	x
0121A	x			x		x		x		x		x	x
0225A	x			x		x		x		x		x	x
0337A	x			x		x		x		x		x	x
0407A	x			x		x		x		x		x	x
0413A	x			x		x		x		x		x	x
0414A	x			x		x		x		x		x	x
0418A	x			x		x		x		x		x	x
0578A	x			x		x		x		x		x	x
0579A	x			x		x		x		x		x	x
0595A	x			x		x		x		x		x	x
0619A	x			x		x		x		x		x	x
0642A	x			x		x		x		x		x	x
0651A	x			x		x		x		x		x	x
0654A	x			x		x		x		x		x	x
1031	x		x			x	x			x	x		x
1032	x		x			x	x			x	x		x
1033	x		x			x	x			x	x		x
0928A	x	CANCELLATION											
0376A	x		x			x		x		x		x	x

Figure C-4 ILS Matrix Checklist (56).

AGERD NO.	NOMENCLATURE	REQUIREMENTS	DIAGNOSTICS EQUIPMENT - EVALUATION CYCLE - PER ENGINE			
			ENGINE BASE LINE DATA (UNINSTALLED)	ENGINE BASE LINE DATA (INSTALLED)	ENGINE FAULT ISOLATION DATA (AS REQUIRED)	ENGINE TREND ANALYSIS DATA EACH 20-30 ENGINE OPERATING HOURS
0708	FWA-50036 ANALYZER JET ENGINE AND FUEL CONTROL	PERFORMANCE TRANSIENT AND STEADY STATE DATA	▲	○	○ ▲	○ ▲
0817	FWA-50037 MACH NUMBER SIMULATOR TEST SET Mn FUNCTION (ONLY)	SYSTEMS FUNCTIONAL CHECKS	▲	○	○ ▲	○ ▲
1031	FWA-50103 TEST SET-ENGINE TRIM BOX	PERFORMANCE DATA AND TRIM FUNCTIONS	▲	○	○ ▲	○ ▲
1032	FWA-50104 TEST SET-(VPTP) VIBRATION-PRESSURE-TEMPERATURE-POSITION	PERFORMANCE DESCRETE POINT DATA TRENDS	●	○	○ ●	○ ●
1032	FWA-50105 TEST SET-(SCS) SUPERVISORY CONTROL SYSTEM	SYSTEMS FUNCTIONAL CHECKS AND TREND DATA	▲	○	○ ▲	○ ▲

▲ Engine Performance Test or After Major Parts Replacement (M-37 Test Stand)

○ Engine Installation Trim and Leak Check or During LRU Maintenance Actions

● Use as Required on M-37 Test Stand to Verify Connect/Disconnect Times-M-37 Instrumentation Provides Data on Similar Units, i.e. Breadboard Diagnostics Units.

Figure C-5. Evaluation Plan F100 Engine Diagnostics Equipment (15).

In August 1973 a Provisioning Conference was conducted for engine diagnostic AGE with a follow-up review held in December 1973. At this December 1973 conference, all AGE items provisioned during the August meeting were reviewed on an "exception" basis. Of the new items reviewed, many vendor and P&WA items were provisioned without the benefit of an approved AGERD. The F-15 SPO/JEPO was to notify P&WA of any changes at the time of AGERD approval. The conference was chaired by the Chief of the AGE Division/ F-15 Systems Program Office and attended by a Provisioning Specialist and Equipment Specialist from San Antonio ALC (55).

It is worth mentioning at this point that the Equipment Specialist from SAALC had never previously attended a Provisioning Conference and was unfamiliar with the sophisticated ground Support Equipment associated with the F100 engine. As a result, the items identified by the contractor on the initial PPB were Source Maintainability Repair (SMR) coded "PB" (17; 44; 45). The "PB" code indicates that the item is "procured and stocked for insurance purposes because essentiality dictates that a minimum quantity be available in the supply system [52]."

As a result of the approved AGERDs P&WA submitted a contract proposal to ASD on 12 March 1974. The proposal outlined two alternatives which could be considered:

Alternative I - physical configuration audit (PCA) was to be accomplished at the vendor's plant prior to delivery;

Alternative II - PCA was not to be accomplished. On 15 April 1974 a contract was awarded to P&WA which stipulated Alternative II be exercised on the initial buy and Alternative I on all subsequent orders. This initial contract specified quantities of two (2) each for part numbers PWA 50103 and PWA 50104, and one (1) each of PWA 50105 with delivery dates of 28 February 1975, 30 June 1975, and 30 November 1974, respectively (3).

The following October a modification to this contract was let to revise and add to the quantities procured under the previous agreement. This new contract dated 11 October 1974 specified quantities and delivery dates as indicated below:

Part No.	Quantity	Delivery Date
PWA 50103	2 ea.	June 1975
PWA 50103	2 ea.	Nov 1975
PWA 50103	2 ea.	Feb 1976
PWA 50104	1 ea.	Dec 1975
PWA 50104	1 ea.	Jan 1976
PWA 50104	1 ea.	Feb 1976
PWA 50105	2 ea.	Dec 1975
PWA 50105	2 ea.	Jan 1976
PWA 50105	2 ea.	Feb 1976 (4)

On 22 October 1975, AGERD Number 2703 (Test Set - Aircraft Engine, PWA 50081) was submitted to ASD by P&WA. The proposed item of ground support equipment was intended

to supercede AGERDs 1031 and 1032 (PWA 50103 and PWA 50104) and consolidate the functions of the two pieces of hardware into a single more flexible and versatile component. In addition, the proposed AGERD 2703 specified an engineering modification be accomplished on existing PWA 50103 and 50104s to combine these items into an equivalent PQA 50081. In December of that year AGERD 2703 was approved by ASD/Support Equipment Engineering Division with the specification that CRS, T.O., and PPB data be provided.

Between 9 and 11 February 1976 the new Engine Trim Box (PWA 50081) was evaluated at Luke AFB, Arizona by the TAC Logistics Engineering Detachment. In addition to problems identified during early demonstrations and testing accomplished at Edwards AFB, California and MCAIR the personnel at Luke AFB discovered, among others, the following problems with the ETB:

1) The lugs on the RCVV transducer were bent during the trial period and were susceptible to damage due to being dropped for forced during installation.

2) The self-calibrating functions failed during testing. The ETB, as a result, had to be returned to the vendor, Howell Instruments, for repair. The incident pointed out the need for defining a maintenance concept and providing necessary T.O.'s and spare parts to the organizational level (37).

Although the new ETB displayed some major and minor deficiencies as previously mentioned, the Engineering Detachment recognized the superior performance and capability over existing equipment and recommended it be provided to the field as soon as possible. In March of 1976 cancellation of AGERDs 1031 and 1032 was recommended and in November cancellation was approved.

At the same time the field evaluation was taking place at Luke AFB, ASD awarded a contract on 13 February 1976 to P&WA for nine (9) Engine Trim Boxes (PWA 50081) to be delivered according to the following schedule:

4 ea - May 1976

1 ea - June 1976

4 ea - July 1976 (5).

Provisioning Follow-up

Subsequent to the acquisition and provisioning phases previously outlined, it was not long before attention was directed toward a concern over the spares support for F-15 AGE. In February 1977, Headquarters TAC queried the Directorate of Materiel Management at SA-ALC as to apparent inadequacies in the support posture of engine diagnostic AGE and munitions test equipment for the F-15. TAC's concern was addressed with regards to the "SMR coding of individual components and failures to initiate timely replacement of insurance items when consumed [28]."

This concern of the F-15 AGE support posture and its possible operational impact instigated a request "to review the supportability of all F-15 AGE to insure that previous provisioning actions were correct and that initial and follow-on support actions were, in fact, accomplished [28]." The request went on to question whether the specified level of repair was correct and supportable by adequate spare parts, and if steps were being taken to initiate reprocurement of insurance items that had been consumed.

In response to TAC's inquiry, SA-ALC sent a message on 18 February 1977 which stated

> we share your concern regarding deficiencies found in the provisioning of a few items of F-15 AGE. We have and are continuing to take action to resolve deficiencies as actual or potential problem areas are identified. We are aware of the problems with spares applicable to engine diagnostic AGE and have taken action to reprovision the equipment and are developing ISSLs. The large majority of spares which were insurance coded during the initial provisioning have been recoded and sufficient quantities of all spares to support F-15 using activities are either on order or will be placed on order in the near future. Cataloging management data changes resulting from reprovisioning are currently being documented for processing through the Federal Catalog System. These changes will eventually be reflected in appropriate Federal Supply Catalog [31].

In order to discuss the concerns expressed above, a working group was convened on 25 May 1977 to review the status of SE spare parts and repair of Diagnostic AGE. As a result of this conference, provisioning reviews were accomplished on numerous items of SE and a recommendation was

made that several pieces of equipment be included in the ISSL. Among these pieces of SE were the following items which were to be identified no later than the date shown:

SE	DATE
PWA 50081	25 May 1977
PWA 50105	10 Jun 1977

With regards to the repair of Diagnostic AGE, the members of the group suggested that SA-ALC/MMIPS expedite work on obtaining a repair contract and advise TAC no later than 1 September 1977 of the contractual status (22).

In accordance with the conference conducted in May 1977, a status report was submitted on 26 September 1977. The report showed the SCS Tester (PWA 50105) to have all actions completed and 100% loaded into the WRM List, Requirements and ISSL (D040). The ETB (PWA 50081), however, was only 75% completed. The reason for the partial action was contributed to the combination of PWA 50103 and 50104. The RIB, it said, was received on 20 July 1977 (32).

In December 1977, the Item Management Division/SA-ALC requested HQ AFLC/LOLSC take necessary action to incorporate the SCS Tester and ETB, among others, into the Maintenance Data Collection System (T.O. 00-20-2) and assign them mission capable (MICAP) reportable Standard Reporting Designators (SRD). Also, these items were tasked to be included in the Maintenance Data Collection System (30). Later that

month, SRDs were assigned these items and authorization for reporting was given by message on 19 Jan 1978 (19).

Despite the many efforts expended to solve provisioning problems for F-15 AGE and specifically the SCS Tester and ETB, another problem-solving conference was deemed necessary. Between 7 and 8 March 1978 a F100 Engine Problem Solving Conference was conducted at which time the details for utilizing newly negotiated repair contracts with the end item vendors was provided.

On 25 Jan 1979, again, a conference was convened at San Antonio ALC to discuss and alleviate continuing problems with the SCS Tester (PWA 50105). It was pointed out by field maintenance personnel that the item had been plagued with deficiencies in numerous areas. Technical Order data, especially, was discussed and identified as having been inadequate throughout its existance. Several modifications, technical data changes, and information updates, they said, were not distributed to the organizational maintenance activities. In addition, the applicable T. O. listed some items needed for calibration and maintenance that were not authorized at unit level in the Table of Allowances (26; 34; 42).

Recent interviews with maintenance personnel indicate little to date has been accomplished as a result of this conference. Though the ETB (PWA 50081) appears to be less of a problem, both the ETB and SCS Tester (PWA

50105) are experiencing significant problems with spares support and supply responsiveness (26; 34; 42). If it were not for the ingenuity and imagination of the maintenance technicians at the organization level, it is suspected that the operational capability and readiness of the F-15 air superiority fighter aircraft would be greatly impaired.

PATTS

As stated in the Delimitation and Scope portion of this thesis, the on-going development and acquisition of the Programmable Automated Trim Test System (PATTS) was to be studied. The purpose of this study was to make a determination as to whether or not this system is being acquired and provisioned in a more adequate method than either the Engine Trim Box or the Supervisory Control System Tester programs.

On 14 August 1979, Pratt and Whitney Aircraft Group (P&WA), Government Products Division, submitted an unsolicited proposal to provide seven (7) automated trim systems for use by the U.S. Air Force (13). These systems (PATTS) were to be provided at no direct cost to the U.S. Government through 31 July 1981. The proposal by P&WA included the commitment to install the systems, train Air Force operator personnel, and provide spares and maintenance support -- all in order to improve the F100 engine trim in the field.

According to the proposal, PATTS provides both consistent and accurate engine trim and also provides savings

in both time and fuel consumption. The PATTS systems to be provided will be essentially identical to the F100 PATTS currently installed and in use at Hill AFB, the site of the first F-16 operational wing. The benefits exhibited at Hill AFB by PATTS were stated in the proposal to include a 35% savings in trim man-hours and a 33% savings in fuel consumption. No supporting documentation was included to verify these data, but P&WA in the proposal stated that "we are offering PATTS for use by the U.S. Air Force because it is proven, available, and provides an immediate solution for improved engine trim [13]."

Among the assumptions on which P&WA based its unsolicited proposal, two are relevant for the purposes of this effort. The first includes the location for the PATTS systems to be provided and the second pertains to the options given the U.S. Air Force upon conclusion of the offer period, 31 July 1981.

P&WA assumed the seven PATTS systems to be provided would be installed at the U.S. Air Force operating bases as shown below:

Air Force Bases	Approximate Installation Date
Bitburg AFB	January 1980
Hill AFB	April 1980
Langley AFB	May 1980
Luke AFB	May 1980
Holloman AFB	June 1980
Eglin AFB	June 1980
Camp New Amsterdam	July 1980 (13)

These bases, with the exception of Hill AFB, are operational sites for the F-15. Hill, as stated earlier, is the site for the initial deployment of the F-16 aircraft.

The second assumption included the options the U.S. Air Force has at the conclusion of the offer period, 31 July 1981. These are:

1. continue no charge use of the PATTS systems with maintenance and spare parts provided by the USAF
2. lease the units
3. purchase the units at P&WA net book value
4. request that the units be removed.

The proposal was concluded with a suggestion by P&WA for a meeting with Air Force representatives to discuss implementation procedures for this proposal, and an initial meeting was held on 22 October 1979.

Participants in the meeting included representatives from P&WA and Howell Instruments (the vendor) and members of the F100 Joint Engine Project Office (YZ100). Discussions centered around the necessity of formulating provisioning plans in case the Air Force chose to become responsible for the maintenance and support of the equipment at the conclusion of the offer period. It was impressed upon both the prime contractor (P&WA) and the vendor (Howell Instruments) that initial provisioning planning should be initiated as early as possible in order to account for the lead times involved in the provisioning process. P&WA and Howell

Instruments were not prepared as of that meeting to provide the USAF with adequate data required for the provisioning process, and thus a letter from the F100 Joint Engine Project Office (YZ100) detailed the required data and other supporting documents needed on which to base any decision (18).

This letter, dated 30 October 1979, issued guidance as to the specific details required by YZ100 to render a proper decision. For subject areas were required to be addressed and resolved before acceptance of the offer, and are outlined and briefly explained below.

1. Technical Data
2. Logistic Data
3. Cost Data
4. P&WA plans for additional sites.

Technical data is required for the duration of the proposal and during the lease agreement, if this option is exercised. Specific requirements included: P&WA technical data and software reflecting configuration of PATTS which will be in place at the field units; updates to software and P&WA technical data to reflect the information contained in the formal Air Force technical orders; P&WA technical data and software are to be revised/changed to keep them current with Air Force technical orders; a procedure for release of revisions/changes to P&WA technical data and software; technical orders in MIL Spec format for operation, maintenance,

and Illustrated Parts Breakdown to cover the option of assuming support by the Air Force; and identification of commercial literature available for repair of PATTS components (circuit cards, etc.).

Logistics data should include Repairable Items Breakdown (RIB) provisioning data; field level maintenance/repair data; tentative training program to repair PATTS; test sheets to be submitted on a monthly basis (See Figure C-6); and a baseline hardware and software configuration. A cost estimate on a per unit basis if the lease option is exercised and P&WA's plan for furnishing PATTS to additional sites as they become activated completed the Air Force's initial response to P&WA's unsolicited proposal (18).

Figure C-7 illustrates the timetable established by the Joint Engine Project Office to incorporate the requirements established in the letter of response so as to obtain information for the best possible decision among the alternatives. The substitution of Camp New Amsterdam with Kadena AFB was made to reflect Air Force deployment desires.

On 2 January 1980, the USAF asked P&WA to submit a cost estimate for contractor support such as maintenance, spares, etc. for the lease of seven (7) PATTS units after July 1981. In addition, a request for a not-to-exceed proposal for the preparation of PATTS manuals in Mil. Spec. format was also included, with these responses by P&WA desired by 31 January 1980 (20).

Period: ______________ Location: ______________ Organization: ______________

PATTS Unit Identifier NO: ______________ Approved by: ______________

1. MTBF ______________ $\text{MTBF} = \dfrac{\text{Total Hours of PATTS Usage}}{\text{Number of Failures}}$

2. MTTR ______________ $\text{MTTR} = \dfrac{\text{Total PATTS Repair* Time}}{\text{Number of Times Repaired}}$ *Actual Repair Time. Do Not Include Down Time.

3. Total Number of Engines Trimmed this Period: ______________

4. Actual Hours PATTS System in Use this Period: ______________

5. Number of Run Sheets Enclosed: ______________

Figure C-6 PATTS Test Sheet (18).

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB
Tech Data & Software Reflecting PATTS Configuration	X													
Release of Revision/Change Procedure	X													
Repairable Item Breakdown (RIB) Provisioning Data	X													
Deployment - Bitburg	X													
Hill				X										
Langley					X									
Luke					X									
Holloman						X								
Eglin						X								
Kadena							X							
Field Maintenance/Repair Data							X							
Baseline Hardware & Software Configuration							X							
A.F. Option Decision							X							
Training Prog. To Repair PATTS									X					
T.O. In MIL Spec Format & Commercial Literature													X	
Test Sheets			X	X	X	X	X							

Figure C-7 Requirements Timetable (18)

P&WA responded on 31 January 1980 as requested, but were unable to comply with the complete requests by the USAF. A cost estimate for follow-on contractor support was not available

> because of a complete lack of maintenance data. For planning purposes only, we suggest $500,000, which includes full maintenance and spares for a period of one year following July 1981, as a reasonable estimate [12].

Concerning the manuals in Mil. Spec. format, proprietary rights problems with the prime vendor's subcontractors were encountered and as of that date (31 January 1980) all required waivers had not been obtained. P&WA proposed a Mil. Spec. format manual for the overall PATTS system, with individual component manuals referenced in the overall manual and would be provided in their present commercial configuration at a cost of $112,000. For full Mil. Spec. formated manuals, a cost of $250,000 was quoted (12).

During the first and second weeks of January, 1980, five (5) personnel from P&WA and Howell Instruments were scheduled to arrive at Bitburg AB, Germany to unpack, set up, and check out a PATTS system, and to conduct the necessary training of Air Force personnel. USAF was to provide a waiver to tech order requirements to authorize use of the PATTS system to trim F100 engines "following notification from P&WA that the PATTS unit is performing satisfactorily and the necessary training of Air Force personnel has been accomplished [16]." This action at Bitburg initiated the

installation and usage as per the schedule agreed to by USAF and P&WA (See Figure C-7).

In a letter of 17 February 1980, the contracting division of the Deputy for Propulsion was tasked to provide contract coverage with P&WA for the use of seven (7) PATTS units at no cost to the government. The lease option would be chosen at the conclusion of the no cost offer in July 1981, and a statement of conditions desired by the USAF was attached. The specific conditions were:

General

Contractor will provide to the government, at no cost, seven F100 Programmed Automated Trim Test Systems (PATTS) including maintenance, repair, spares support, training of Air Force personnel, and instructions required for use at one USAFE, one PACAF, and five TAC bases from 1 Jan 1980 to 31 July 1981.

Installation

Contractor will deliver and install PATTS systems in accordance with the following schedule.

Bitburg AB, GE	Jan 1980
Hill AFB, UT	Apr 1980
Luke AFB, AZ	May 1980
Holloman AFB, NM	May 1980
Langley AFB, VA	June 1980
Eglin AFB, FL	June 1980
Kadena AB, JA	July 1980

Shipping instructions will be provided by the PCO upon request by the contractor.

Contractor will provide all maintenance, parts, and software updating throughout the period of performance at no cost to the Government, provided that the contractor is under no obligation to replace the Patts in the event of destruction or extensive damage.

Training

Contractor will provide a thirty hour training program, as required, for Government personnel. Training will cover operation, interpretation, and troubleshooting of the system.

Government Support

During the period of performance the Government will perform preliminary troubleshooting and fault isolation, if required. The Government will also maintain a log for reporting the usage of the trim system, report any problems encountered, calibrations, etc.

Technical Data

P&WA tech data and software reflecting configuration of Patts units will be in place at the field units at the time of delivery. Technical data is to be identified by nomenclature, data, and change/revision dates if applicable.

P&WA will update software and P&WA technical data to reflect the information contained in the formal Air Force tech orders, i.e. 2J-F100-6-2. P&WA tech data and software are to be revised/changed to keep them current with Air Force tech orders.

P&WA will provide a procedure to the Air Force within 60 days from date of this agreement for the release of revisions/changes to P&WA tech data and software [58].

The lease option was exercised because a military system was to be developed and procured to replace the PATTS system. In the interim, the USAF would require contractor support for the PATTS units in the field, and the lease option would go into effect at the conclusion of the no cost offer in July 1981. The $500,000 planning estimate was assumed to include all the PATTS systems in that offer (58).

As of this writing, 31 March 1980, no further developments had occurred with the PATTS acquisition program,

and thus only those activities included up to that date will be utilized in this research effort.

SUMMARY

On 1 March 1970, ASD awarded a contract to United Aircraft Corporation/Pratt and Whitney Aircraft Division to continue with the development of the F100-PW-100 engine for the F-15 fighter aircraft. This contract (Item four) specified Aerospace Ground Equipment (AGE) to be developed to support the engine. This equipment was to be selected in accordance with AFPI 71-685 entitled "Aerospace Ground Equipment Identification/Selection/Acquisition/Provisioning Document for USAF Contracts."

Thus, AGERD numbers 1031, 1032, and 1033 proposed engine diagnostic equipment necessary to: monitor engine conditions while trimming the F100 engine; monitor engine parameters when analyzing abnormal conditions or establishing performance trends; and analyze the inputs/outputs of the electronic supervisory control. Subsequently, AGERD numbers 1031 and 1032 were combined to form the Engine Trim Box, while 1033 identified the SCS Tester, two of the pieces of Support Equipment studied in this research.

These AGERD proposals met early difficulty with several groups not initially approving due to various factors. Among these were the insufficiency of the data to adequately review the AGERD items for operational use and to

determine the suitability of the approved hardware. However, on 18 August 1972, the AGERDs were conditionally approved pending satisfactory completion of technical design reviews and field service testing, followed by final approval on 10 August 1973. On both the conditional and final approval dates CRS, T.O., and PPB data were addressed as being required.

A Provisioning Conference was then conducted for engine diagnostic AGE with a follow-up review held in December of 1973. The items identified by the contractor on the initial PPB were SMR coded PB -- the item is procured and stocked for insurance purposes because essentiality dictates that a minimum quantity be available in the supply system.

After several months of operational use, these pieces of equipment became items of concern when the spares support for F-15 AGE appeared deficient. Provisioning deficiencies were discovered and a May 1977 follow-on provisioning conference was held to correct the original provisioning effort. Not until January of 1978 were the Engine Trim Box and SCS Tester assigned Standard Reporting Designators and authorized reporting in the Maintenance Data Collection System.

Problems continued to plague these two pieces of equipment, and between 7 and 8 March 1978 a F100 Engine Problem Solving Conference was conducted. In addition, on 25 January 1979, a conference was held concerning the SCS

Tester with problem areas identified as having been inadequate throughout its existence -- technical order data and information updates, to name a few. Recent interviews with maintenance personnel indicate little has been accomplished as a result of these conferences, and that both the Engine Trim Box and SCS Tester remain plagued by significant problems with spares support and supply responsiveness.

PATTS (Programmable Automated Trim Test System) was the subject of an unsolicited proposal by Pratt and Whitney Aircraft to provide improved engine trim for the F100 in the field. This proposal, dated 14 August 1979, was to provide the Air Force with several options for the eventual long-term use of the system. An analysis of this proposal and the Air Force response was undertaken to determine whether or not this system is being acquired and provisioned in a more adequate method than either the Engine Trim Box or the SCS Tester programs.

An initial meeting was held in October 1979 with representatives of all concerned parties in attendance. Items discussed included the types of information and data required for the Air Force to adequately evaluate each option, with the prime contractor and its vendor agreeing to provide the required information in a letter.

Once this information was reviewed by the Air Force, the lease option was chosen due to the fact that a military system was to be developed and procured to eventually

replace the PATTS system. Thus, the activities which took place between August 1979 and 31 March 1980 were reviewed so as to determine how an example of present-day Support Equipment is being acquired.

Chapter 4

INTRODUCTION

The purpose of this chapter is to present an analysis of the research findings as a result of this study. This will be accomplished by an examination of the research questions, as stated in Chapter 1, and an evaluation of each question individually based upon the available documentation and personal interviews conducted by the authors.

A brief review and summary of the provisioning process is provided in the following pages. This review will be provided prior to the detailed analysis of the research questions posed by the authors and will, hopefully, provide the reader with a basic knowledge of the provisioning process as it is intended to occur.

Some generalizations of this study were necessary because of the uncertainties encountered during the investigation of chronological events. However, the authors believe that the following analysis represents an ingight into an actual provisioning effort with regards to specific examples of Support Equipment (SE).

DEFINITION OF TERMS

Programming Checklist --

> A form which portrays the Air Force planned programming data for the end item on contract. The data

> is utilized to forecast an interim release to production and procurement or to recommend items and quantities required to maintain the end article in the initial phase of operation [48].

Insurance Item --

> Items which are not subject to periodic replacement or wearout. Replacements, resulting from accidents or other unpredictable occurrences, are required so infrequently that procurement is made in limited quantities and held at a central point or obtained from contractor sources [9].

THE PROVISIONING PROCESS

The following section will be devoted to a brief summary of the provisioning process as presented in AFR 67-2, Supply Management Reference Book, and AFLCR 65-5, Air Force Provisioning Procedures and Policies. This narrative of the provisioning process is taken substantially from "Initial Provisioning", an Air Force Institute of Technology (AFIT) unpublished report, by Capt. George M. Farnell (25).

Provisioning is one of the most important logistics processes, and is broadly defined as the laying-in of an adequate supply of material, when and where needed and within monetary constraints, to support a weapon system or end item of equipment during its initial period of operation. There are many elements to be considered in provisioning; three of the most important are:

1. Maintainability - Will we try to repair the item or discard it at failure?

2. Maintenance Concept - Will we repair at the Organizational, Intermediate or Depot level, or forego organic maintenance in favor of contractor support?

3. Reliability - What is Mean Time Between Failure (MTBF)? What is the Mean Time Between Demand (MTBD)? How often will items have to be replaced?

Technically, formal provisioning does not begin until contract award; however provisioning planning begins as soon as a new system is conceived. Actual provisioning documentation begins with the request for proposal, invitation for bids and request for quote to contractors. In the case of Support Equipment, the hardware is usually proposed by a contractor to support a major weapon system. In order to identify the requirements and functions of the proposed equipment, a SERD is submitted to the Aeronautical Systems Division (ASD) for review and approval. Once the need is recognized, and it is determined that the requirement cannot be filled with existing hardware, the SERD is approved and a contract is awarded. The first meeting with the contractor after contract award is the guidance conference. This conference is mandatory and is held as soon as possible but not later than 30 days after contract award.

At the guidance conference, the Air Force advises the contractor specifically what is expected of him. He is given a thorough orientation in the Air Force method of requirements determination, cataloging, and data and

documentation requirements. The time frames established on the Provisioning Plan are converted to calendar dates, and these dates become milestones for Air Logistics Center provisioning and contract administration personnel to monitor progress toward delivery of repair parts for the system/end article by need dates. The conference thus establishes or confirms the provisioning policy and technical guidance to be followed in the initial selection of items and quantities needed to support the system under the basic contract and enables all parties to reach accord on contractual requirements.

As the contractor completes engineering on the various sections or components of the system, he will submit Provisioning Technical Documentation (PTD) as requested under the contract to the AFLC System Manager/End Article Inventory Manager (SM/EAIM). PTD consists of drawings, Recoverable Item Breakdown (RIB), etc. These documents provide the necessary information to the SM/EAIM and the equipment specialists, i.e., manufacturer's part numbers, nomenclatures, descriptions, estimated prices, and recommended quantities.

The equipment specialists of the Air Logistics Centers assign the source (SMR) codes and factors which determine the range and influence the quantity to be procured. These factors influence the gross requirements for intermediate and organizational repair parts. For recoverable type items, the contractor will be requested to prepare and

submit recoverable item breakdowns. The item manager then takes action to consider all assets and to determine the net requirement, and orders are placed with either the prime contractor or actual manufacturer of the item in accordance with established policy.

Source coding of the new items to be provisioned will occur at a time and place agreeable to both the contractor and the Systems Manager from the appropriate Air Logistics Center. The date established must be early enough to meet contractual delivery requirements for new items coded as buy items. Participants in the provisioning conference are the contractor, the system manager, and the end article item manager. Equipment specialists who are responsible for source coding and factoring, and cataloging technicians who accomplish the necessary cataloging and standardization actions should also be present. The purpose of the source coding process is to determine the range of items required for support. The team's important functions are to establish maintenance factors, determine recoverability status or expendability codes, determine appropriate level of maintenance, and indicate to the user the source to which he must look for supply support.

The contractor has a continuing responsibility to submit to the Air Force additional management or technical data, such as changes, additions, or deletions during the life of the production contract. Air Force procedures

require the contractor to adjust the quantity of repair parts already on order with the quantities of repair parts needed to support approved design changes.

In the Air Force, the responsibility for provisioning is vested in the Air Force Logistics Command. The headquarters of AFLC has responsibility for provisioning policy and procedures and the development of concepts and techniques. Physical accomplishment of provisioning actions is assigned to the Air Logistics Center. The center designated as the end article item manager has the responsibility for insuring that assigned systems/end articles are provisioned in a timely and adequate manner. Air Force Logistics Command must work closely with the System Project Office of the Air Force Systems Command in order to follow the development and production of a system and insure appropriate provisioning interface with systems development.

The preceding brief overview of certain aspects of Air Force provisioning should acquaint the reader with the areas to be stressed in the following analysis of the items of F100 Support Equipment studied in this thesis. Hopefully, this should form a basis for comparison and reference, and eliminate any bias in the analysis.

ANALYSIS

Research Question Number One

What have been some of the more common provisioning deficiencies that were characteristic in the area of

support equipment as exemplified by the SCS Tester and Engine Trim Box?

A. Concurrency. According to AFR 800-12, "Acquisition of Support Equipment," the SCS Tester and ETB fall into the category of "prototype" hardware. It says,

> Prototype support equipment is the type which must be developed simultaneously with the development of the mission system because of high technological interfaces, long leadtime for development, and an early requirement date for support. This type is highly sensitive to design changes in the system . . . [49].

With this type of equipment, as was the case with the SCS Tester and ETB, final configuration and design specifications are identified after the prime system is well along in its development or even into production. For this reason SE is typically rushed through its final stages of testing and is procured and provisioned in a condensed time frame in order to be available for operational deployment.

From the previous chapter it can be seen that the basic P&WA F100 contract was awarded in March 1970. This contract stipulated a delivery of the first production engines (59 each) in fiscal year 1972. The AGERDs (1031, 1032, and 1033), however, which outlined the requirements for the SCS Tester and ETB were not submitted until May 1972 with a final contract modification (MOD P00161) not awarded until April 1974.

During the early stages of testing in the development of a new weapon system such as the F100 engine, the

emphasis is placed on adhering to test schedules and performance milestones. Typically SE in this environment receives little attention and inadequate time and energy is devoted to evaluating these items. As a result compromises are made, time becomes critical, and the Air Force is eventually forced to live with unsatisfactory SE to support the first operational units. The ETB, for example, was in the field nearly two years before the deficiencies were completely identified and a new configuration (PWA 50081) was proposed which would more adequately meet the requirements of the field units (23).

"Prototype" support equipment will always be subject to the time constraints indicative of both the SCS Tester and ETB. As newer and more sophisticated weapon systems are developed in the future, the technological advances necessary in SE will continue to grow at an equal, or faster, pace. For this reason, state-of-the-art designs are essential and concurrent development of SE and prime systems will become more prevalent. The problems encountered with the SCS Tester and ETB, therefore, cannot be considered unique and one-of-a-kind.

If simultaneous development of SE and prime systems [illegible] considered necessary and continuing, as the authors be-[illegible]eve, then the system for acquiring these SE items must [illegible] greater emphasis and be capable of meeting the re-[illegible] demanded. The SCS Tester and ETB, as will be

seen, were glaring examples of how the then present acquisition and provisioning management network failed to provide critical SE in a timely and supportable manner to enhance the operation of the primary weapon system.

B. SERD Processing. Before a discussion of the AGERD/SERD flow and processing, as it related to the SCS Tester and ETB, can be accomplished it must be pointed out that the current AFLC Regulation 65-5, "Air Force Provisioning Policies and Procedures," is dated 22 December 1975. This regulation and many of the ILS concepts (to be discussed later) were in their infancy during the conceptualization and development of the two subject items of SE, the SCS Tester and ETB. Though the current directives are dated after the period of concern AFLCR 65-5 which superseded AFLCM 65-3/AFSC 65-2 dated May 1965 incorporated the same basic notions with regards to provisioning policies and procedures. For this reason, and the fact that the lessons learned from the experiences of the SCS Tester and ETB could be applied to existing patterns of systems acquisition, the current directives and guidelines were utilized to evaluate the events which contributed to the shortcomings of F-15 SE.

With this in mind, it should be understood that the current directives suggest that "the early identification, development, adequacy, and timely procurement of SE items is imperative . . . [8:41-1]." To accomplish this end,

certain time cycles have been established to enhance the smooth and expeditious processing of documents essential to the acquisition and provisioning of new pieces of hardware. In the case of SE, AFLCR 65-5 specifies that after contract award for a system/end item the contractor will submit a Support Equipment Plan (SEP) within sixty days. Once the plan has been reviewed for approval the contractor should prepare and submit Support Equipment Requirements Data (SERD/AGERD) on each item of SE.

The SERD should consist of functional and physical descriptions of the item and its use. Though this early data is submitted prior to the availability of detailed drawings and information, the SERD is reviewed by numerous agencies (Figure D-1) which must determine and comment on such things as cataloging, technical services, maintenance functions, and suitability. The inputs from these agencies are invaluable if intelligent decisions are to be made as to the adequacy of the contractor proposal. For this reason, the information contained within the SERD must be as comprehensive and specific as is feasibly possible.

The AGERDs which proposed the SCS Tester and ETB (Numbers 1031, 1032, and 1033) were submitted to ASD in May 1972. This date was approximately two years after the prime engine contract was awarded and very near the delivery date for the first production engines. It was previously pointed out that the specific need for either of these items

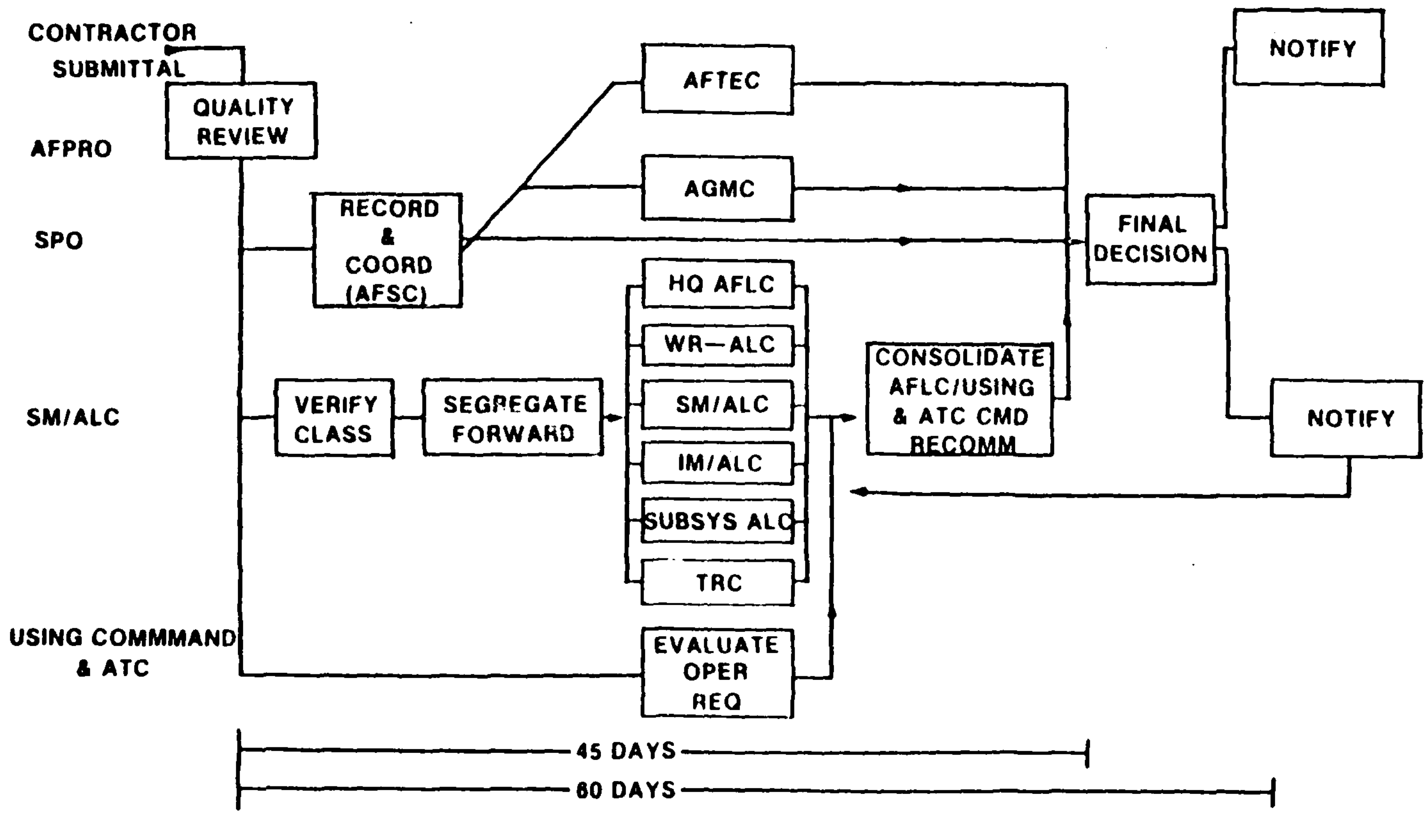

Figure D-1 Abbreviated SERD Flow Chart (1).

of SE, the SCS Tester and ETB, was not identified until well into the flight testing phase of development. This excessive delay generated numerous problems later in the timely deployment of operationally adequate and supportable items.

In order to accommodate the leadtime requirements associated with the design, development, and deployment of "prototype" hardware, the time phases outlined in AFLCR 65-5 must be adhered to as much as possible. The SCS Tester and ETB AGERDs were not only excessively long in being submitted but when they were presented for review and approval they did not include the information necessary for proper coordination.

Three coordinating agencies (the Propulsion and Power Branch/ASD, the Weapons Systems Development Division/ HQ TAC, and the Jet Engine Propulsion Office Engineering Division) withheld approval or recommendations because of insufficient information required to make determinations with regards to operational use and suitability. As a result, an additional year passed before adequate clarification could be obtained to warrant final approval.

Though the AGERDs for the SCS Tester and ETB prepared by Pratt and Whitney Aircraft (P&WA) and submitted to ASD were deficient in many respects, it must be pointed out that these documents were not necessarily unique in this regard. In fact, AGERDs 1031, 1032, and 1033, in some areas, were better than similar documents forwarded for

review by other vendors of SE. Unfortunately, time constraints prevented the solicitation of critically needed clarification and resulted in problems of maintainability and supportability being encountered well after the hardware was introduced into the inventory (38).

In an attempt to alleviate some of these problems of maintainability and supportability the concept of Integrated Logistics Support (ILS) was developed and utilized during the F-15 development and, more specifically, during the F100 engine development. The SCS Tester and ETB were just two of many items which were incorporated into the concept.

ILS must be considered, says AFR 800-8,

> during the early phases of conceptual development, validation, and full scale development of a system or equipment life cycle, when trade-offs to determine an optimum balance between total system effectiveness, cost, and schedule can influence hardware design. Optimum design will be achieved only if logistics considerations and planning are integrated during the system's engineering and design process [50:2].

To accomplish this objective an Equipment Specialist/ILS Directorate was assigned to the F-15 System Project Office (SPO) in order to coordinate and consolidate the inputs from designated AFLC agencies. These agencies, to include the Item Manager (IM), Aerospace Guidance and Metrology Center (AGMC), and HQ AFLC provided recommendations which should have facilitated operational and logistic effectiveness once the items were procured (57).

In the case of the SCS Tester and ETB, ILS consisted of a coordination letter from the ILS Directorate with a

matrix type checklist (See Figure C-4) identifying a requirement for Provisioning Parts Breakdown (PPB), T. O., and Calibration Requirements Summary (CRS) data. At no time did the agencies responsible for ILS inputs have the opportunity to meet or be in contact with representatives of P&WA, the SPO, or the proposed vendors (Howell Instruments and Hamilton Standard) to request clarification and/or to coordinate the details of the necessary data.

The impact of this limited access and coordination was evident throughout the SCS Tester and ETB's operational history. The initial PPB as submitted was inadequate, the T.O.s were plagued with problems from the very beginning, and the CRS provided little assistance in establishing calibration intervals and procedures (38; 42; 44).

Realizing that the concept of ILS was new during the F-15 conceptualization and development, it appeared that the basic precepts of the ILS program were violated and its purpose was not accomplished. A program which was to consider logistics support throughout the acquisition cycle was needed, valid, and necessary. Unfortunately, in the case of F100 engine diagnostic SE, ILS was no more than a strawman.

From the available documentation and information, the AGERD/SERD review and approval cycles as outlined in AFR 65-5 appeared to have been followed with the exception of adhering to certain suggested time frames. A significant factor which contributed to the variation of these time

phases was the insufficient information incorporated into the basic format of the submitted AGERDs. This problem was compounded by the lack of active participation and involvement by critical support agencies in the final approval process. Though these agencies were included in the approval flow, their inputs were consolidated and submitted to the program manager by a single individual who was unfamiliar with each one's peculiar requirements.

C. Requirements Determination and SMR Coding: Technically, the provisioning process does not begin until after a contract is negotiated and awarded. Prior to final contract award, and specifically in the case of SE, many steps are initiated to set the provisioning plans into operation. As pointed out in the previous chapter, for example, the Item Manager (IM) uses information abstracted from the proposed AGERD/SERD to fill out AFLC Form 323A, Requirements Data Worksheet. This data is then incorporated into the AFLC Form 29, Programming Checklist, which not only provides guidance to the Provisioning Officer and Inventory Manager concerning the pending acquisition but also is used in forecasting future spare item procurements.

As was previously pointed out, the information included on the AGERD/SERD was incomplete, sketchy, and only indicated proposed quantities of end items for the initial buy. For the SCS Tester and ETB, the numbers used for initial requirements determination were three and two

respectively (See Figures C-1, C-2, C-3). Despite the IM's anticipation of additional end item acquisitions as more operational units were brought into being, he was confined by directive to enter the quantity of end items procured requiring support on the Form 29 (8). The best information available to the IM for this number was that quantity proposed on the submitted AGERD/SERD. Using the data from the Form 29, the Inventory Manager bought only enough spares to accommodate that requirement.

In his efforts to complete the worksheet (Form 323A) computations, the IM had at his disposal only the information contained on the AGERD. At no time was he privy to the contents of the long-range procurement schedule or actual contract that was eventually awarded by ASD. For this reason, the IM was not informed or knowledgeable of the finally established or projected quantities of end items to be procured for organizational, intermediate and depot levels. This lack of communication and coordination between the ALC and ASD significantly hampered efforts to reasonably forecast required spares for provisioning (44; 54).

According to the IM at the SA-ALC, the problems encountered with the SCS Tester and ETB in requirements determinations are not unique. Completion of the Form 29 is continually delayed as long as possible and is typically not provided until absolutely demanded by the Provisioning Officer. This delay, though it significantly contributes

to late and degraded coordination, is considered essential to allow the IM time to gather all available data and facilitate the determination of end item quantities contracted for by ASD. In many instances this information can only be obtained by the IM's initiative in gaining access to the final contract. Even in this case the information is limited to original acquisitions of SE and does not provide any insight into follow-on procurements (44).

With the information provided by the IM on the Form 29, the Provisioning Officer prepares to attent the Provisioning Conference. Since SE is provisioned in the same manner as any other high dollar spare item, attendance at this conference and SE representation is usually limited to the SE Provisioning Officer and an Equipment Technician from SA-ALC. Due to the critical nature of this conference for future provisioning planning "only the best qualified and most capable personnel will be delegated the important responsibility of provisioning and source, maintenance, recoverability (SMR) coding [8]."

Unfortunately, in the case of the SCS Tester and ETB, the designated Equipment Technician tasked to perform this responsibility was not the best qualified. He was not able to provide the necessary expertise to properly identify and evaluate the highly technical and sophisticated state-of-the-art engineering associated with both pieces of equipment.

As a result, all items on the Recoverable Item Breakdown were SMR coded insurance (PB) type expendable items (44; 53; 54).

This SMR coding, coupled with the limited quantities of end items identified in the early requirements determination, created extensive supportability problems. These problems quickly surfaced when a large number of requisitions for the insurance type items began to exhaust supplies faster than reprocurement actions could be generated. It was not until the Inventory Manager recognized the critical nature of the situation and identified it as jeopardizing the support of the SCS Tester and the ETB that a review took place and recoding and reprovisioning were accomplished.

In addition to the limited quantity of spare parts required by the insurance source codes assigned at the provisioning conference, the expendable nature of the items implied by the PB designation preempted action to consider depot or contract repair capability. Once the mis-coding surfaced as a major error in the provisioning process, the lead time in developing a depot repair capability or negotiating an equitable contract for commercial repair was extensive. Though an interim repair contract with the end item vendors (Hamilton Standard and Howell Instrument) was finally arranged, it was done at considerable expense and entailed a significant delay in the support provided to the field organizations (21).

Research Question Number Two

What provisioning procedures are presently being accomplished on currently developing support equipment (PATTS) peculiar to the F100 engine that may portray any improvement in the provisioning process for support equipment?

As indicated in an earlier chapter, the Programmable Automatic Trim Test System (PATTS) was the subject of an unsolicited proposal by P&WA to provide improved engine trim for the F100 engine. An analysis of this proposal caused the Air Force to approach this potential acquisition in a much improved manner when compared to the SCS Tester or Engine Trim Box (ETB) acquisition programs. Some aspects concerning the contractor's follow-up responses raised some questions.

It must be stressed at this point that a direct comparison of PATTS with the earlier programs cannot be made due to several factors. The SCS Tester and ETB were developed concurrently with the engine while PATTS is a later development and thus not subject to the effects of a changing engine configuration as were the earlier programs. PATTS was developed with a technology base which was fairly stable when compared to the earlier programs which were developed with techniques that were on the forefront of technology. One must consider these factors, but should not allow them to overshadow the points of commonality these three pieces of support equipment share.

As indicated in the previous chapter, PATTS was not exposed to the formal provisioning process, but was subject to the provisioning planning phase as explained in the introduction of this chapter. Although no formal provisioning conferences were held as such, the meeting described in the preceding chapter provided the forum for the Air Force to present to the contractor and vendor the Air Force method of requirements determination, cataloging, and data and documentation requirements.

Had the option been exercised by the Air Force to acquire the PATTS systems, the necessary logistics planning would have been accomplished to provide for the orderly transition of the systems from contractor to Air Force responsibility. This judgment is supported by the detailed requirements outlined by the Air Force to include technical, logistic, and cost data.

The logistic data specified several areas which would have provided a firm basis for any provisioning that was to follow. The inclusion of Recoverable Item Breakdown (RIB) data, field level maintenance/repair data, tentative training program to repair PATTS, test sheets for monthly submittal, and a baseline hardware and software configuration form the nucleus for any program to be properly provisioned. These specifications did indeed satisfy the three elements of provisioning necessary to support the

end item of equipment during its initial period of operation; i.e., (a) Maintainability, (b) Reliability, and (c) The Maintenance Concept (See "The Provisioning Process," this chapter).

As indicated earlier, some of the aspects concerning the contractor's follow-up responses raised some questions. In the initial proposal from P&WA, PATTS was touted as being a proven and available system that would provide an immediate solution for improved engine trim. When the Air Force queried the contractor for a cost estimate for contractor support, P&WA responded negatively due to their "complete lack of maintenance data." The question in the authors' minds concerns how the contractor can truthfully state a system is proven and reliable and then be unable to provide data which would be available to support their assertion.

Further provisioning efforts were not necessary in that the lease option was exercised by the Air Force. However, the provisioning groundwork had been firmly laid had the acquisition option been selected. It should be emphasized that this situation may not be typical of all current SE acquisitions due to the personal involvement of the Deputy Program Manager for Logistics (DPML/YZ100) within the Propulsion SPO and representatives from the Support Equipment System Project Office (SESPO). One may not assume that this attention is being given to all acquisitions, but the report remains that adequate attention was given to this particular case.

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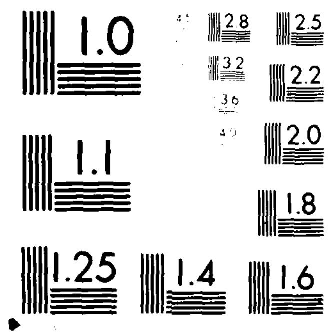

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Research Question Number Three

Are the current and existing regulations and directives adequate to insure support of support equipment when consolidated into the acquisition of a major weapon system?

This question was incorporated into the interview guide in order to acquire a feeling for the attitudes and opinions at all echelons of the acquisition and provisioning process. San Antonio Air Logistics Center personnel believe the guidance in the regulations and directives have been adequate for several years, and do not believe there has been a general lack of guidance (53; 54). Opinions tended to diverge when the interpretation of those directives and regulations were discussed.

Although there have been no substantial changes in the regulations concerning provisioning, the methodology employed by various personnel to carry out those regulations is open to varied approaches. These variations occur due to the interpretations by the personnel involved, which often leads to differing courses of action. The regulations should be carefully evaluated periodically, but one cannot eliminate the human factors involved (44; 45; 54).

Generally, personnel interviewed felt that the regulations should be made as flexible as possible due to the variability of circumstances which could develop when provisioning different items. Specifically, a recommendation commonly given concerned a revision to the regulation

concerning the programming checklist in the area which limits the Item Manager's ability to purchase spare parts (44; 45).

Presently, the Item Manager cannot purchase spare parts for more units than is currently ordered, even though the probability of acquiring more items in the future is quite high (8). This caused extensive problems in the SCS Tester program. The Item Manager could not take into consideration the projected increased acquisition, and thus could only provision for a two year period against the number initially acquired (9). When the requirement for those subsequent purchases were made known to him, he was "lead time away" from being able to supply the spare parts to be required (45).

Research Question Number Four

What were the effects of improper provisioning of specific support equipment for the F100 engine (1) on the operational readiness of the weapon system (aircraft), and (2) on maintenance procedures and schedules for the F100 engine itself?

With the answering of this question, the authors hoped to demonstrate the effect of the non-availability of support equipment on a weapon system. As indicated in an earlier chapter, all appropriate data except that for the support equipment led to the natural pursuit of determining

the cause or causes of this deficiency, and in turn raised questions relative to the processes involved in the reporting of maintenance data.

Interviews with maintenance specialists at HQ/AFLC indicated the time period between the acquisition of the SCS Tester and Engine Trim Box and their incorporation into the maintenance data collection and reporting system (D041) was grossly excessive. These individuals indicated data on equipment should be incorporated into the reporting system as soon as possible after initial acquisition with the specific timing left to the judgment of the particular system manager or item manager in the case of support equipment (27; 47). At any rate, the elapsed time between the acquisition and initial reporting of the SCS Tester and ETB (March 1974 and December 1977, respectively) was unnecessarily excessive and resulted in the incompletion of one of this thesis' primary objectives.

In partial defense of those responsible for the establishing of maintenance data reporting, it should be made clear that in cases of limited numbers of items of support equipment, i.e., four or less, maintenance reporting is seldom required. As indicated in the previous chapter, the initial number acquired was three of the SCS Tester and two of the ETB. These factors could have had an effect on the lack of maintenance data reporting for these two pieces of support equipment. The subsequent acquisitions should have generated a need for maintenance data reporting.

Another aspect to be considered is the lack of input from the Type IV PMELs (Precision Measuring Equipment Laboratories) concerning the frequency of component failure and subsequent non-availability of the support equipment. Reasons given for this lack of input included the total lack of spare parts supported from San Antonio Air Logistics Center. When spare parts support was required, none was forthcoming due to lack of parts on hand. This futile procedure of requests for parts was subsequently dropped, thus deleting any input which would determine usage rates for various components and provide data for the maintenance data reporting system (26; 34; 42).

The absence of the Log 20 (Precision Measuring Equipment Calibration Interval) report established by the Aerospace Guidance and Metrology Center (AGMC) also raised questions concerning its non-availability. This report is required in order to determine appropriate calibration intervals for any specific piece of equipment - including the SCS Tester and ETB - and includes maintenance data similar to that included in the D041 system. Without this data, no evaluation is possible as to the appropriateness of the initial calibration interval established. As in the case of the lack of data in the D041 system, the absence of data in the Log 20 report for the SCS Tester and ETB raised questions as to the reason, and whether or not our expectations were presumptuous.

An interview with the calibration systems manager for the F-15 (which includes the SCS Tester and ETB) failed to adequately resolve the question concerning the lack of Log 20 reporting. When queried as to the reason for this lack, the systems manager indicated this data should perhaps have been incorporated earlier, but the workload had not allowed for the required implementation procedures for the Log 20 report - a full six years after initial acquisition for the SCS Tester and ETB.

Thus, the absence of maintenance and calibration summary data precluded the attaining of one of the more important research objectives; that of determining the effect, if any, of non-availability of support equipment on the weapon system it supports. However, the discovery of this lack of data raised further questions as to the mechanics of maintenance data reporting for support equipment which will be addressed in the next chapter.

SUMMARY

Provisioning is one of the most important logistics processes. It is broadly defined as the laying-in of an adequate supply of materiel for use when and where needed and within monetary constraints, to supports a weapon system or end item of equipment during its initial period of operation. The purpose of this chapter was to present an analysis of the research findings. The findings are based on a

standardized provisioning framework, an analysis of available documentation, and personal interviews conducted by the authors.

Research Question Number One

a. The concurrent development of both the SCS Tester and ETB along with the development of the engine resulted in problems for the Air Force. Compromises were made due to time compression, and the Air Force was eventually forced to live with unsatisfactory SE in order to support the first F-15 units. The system for acquiring these types of SE items (concurrently-developed) should have received greater emphasis and been capable of meeting the requirements demanded of it.

b. Early approval of the original AGERDs for the SCS Tester and ETB was withheld due to insufficient information which was required to make determinations with regards to the items' operational use and suitability. As a result of this delay, the Integrated Logistics Support (ILS) effort failed to accomplish its goal, that of determining an optimum balance between total system effectiveness, cost, and schedule. This problem was compounded by the lack of active participation and involvement by critical support agencies in the final approval process.

The long-range procurement schedule was not made available to the Inventory Manager (IM) who procured spares

based on the AGERDs. The AGERDs covered only an initial purchase and the IM could not provision for additional items that were then being planned for purchase. This lack of communication and coordination between the ALC and ASD significantly hampered efforts to reasonably forecast required spares for provisioning.

c. The source, maintenance, and recoverability (SMR) coding conference was attended by an Equipment Specialist who was not the best qualified. All initial RIB items were SMR coded insurance (PB) type expendable items. This SMR coding, coupled with the limited quantities of end items identified in the early requirements determination created extensive supportability problems.

Research Question Number Two

PATTS was the subject of an unsolicited proposal by P&WA to provide improved engine trim for the F100 engine. The Air Force analysis of this proposal and their response caused the Air Force to approach this potential acquisition in a much improved manner when compared to the SCS Tester or ETB acquisition programs.

Research Question Number Three

When the analysis of the regulations and directives was made, it was determined that no substantial changes in the regulations had occurred. However, the methodology employed by various personnel to carry out those regulations

was open to varied approaches. This occurred due to the interpretations by the personnel involved, which could and often did lead to differing courses of action.

Research Question Number Four

The statistical effort to determine the effect of any non-availability of the SE on the weapon system could not be accomplished due to the lack of maintenance data on the SCS Tester and ETB. Although acquired in the early 1970s, these pieces of SE were not incorporated into the D041 system until 1978, and not at all in AGMC's LOG 20 report. The reasons for this were investigated, with the general observation being that these were oversights combined with a lack of available time for such accomplishments.

Chapter 5

CONCLUSIONS

The conclusion of this research effort will be based on the research questions addressed in the previous chapter, and consist of the facts revealed by this study along with the authors' judgments. The format for this section will necessarily consist of addressing each question individually, with the recommendations to follow in a separate section.

Research Question Number One

What have been some of the more common provisioning deficiencies that were characteristic in the area of support equipment as exemplified by the SCS Tester and Engine Trim Box?

A. Concurrency: Concurrent development of SE and the weapon system it supports is necessary and required in many instances. The concurrent development of the SCS Tester, ETB, and the F100 engine resulted in the SE receiving too little attention for satisfactory development. The procedures involved in this SE acquisition process must receive greater emphasis and be capable of supporting the system for which it was designed. Compromises must not be made which discriminate against the SE, for as newer and more

sophisticated weapon systems are developed in the future, technological advances necessary in SE will continue to grow as well.

B. SERD Processing: The excessive delay from initial contract award until AGERD processing generated numerous problems in the deployment of operationally adequate and supportable items. Due to the deficiency in quality of the AGERDs, approval and recommendations were withheld which were required to make determinations in regard to operational use and suitability.

The lack of Integrated Logistics Support emphasis on the SCS Tester and ETB resulted in an inadequate Provisioning Parts Breakdown (PPB), deficient technical data (to include tech. orders), and a lack of guidance in establishing calibration intervals and procedures. Therefore, the authors conclude the AGERD/SERD review and approval cycle (which includes involvement by critical support agencies) is of the utmost importance in the initial phases of SE acquisition.

C. Requirements Determination & SMR Coding: Data from the AGERDs were used to provide guidance to the Provisioning Officer and Inventory Manager and were also used in forecasting future spare requirements. This data reflected unrealistic numbers, and no long-range procurement plan was made available to the IM for a more realistic spares requirement. The lack of communication between the ALC and

ASD impaired efforts to reasonably and accurately forecast required spares for provisioning. The IM must have access to all available information as early as possible, and this information must be accurate.

Due to the inexperience of the Equipment Technician at the Initial Provisioning Conference, the items were mis-coded insurance type items. This SMR coding, coupled with the limited quantities of end items identified in the early requirements determination, created extensive supportability problems. Therefore, the requirements determination and SMR coding processes failed to provide the necessary provisioning planning required for adequate support of the SE.

Research Question Number Two

What provisioning procedures are being presently accomplished on currently developing support equipment (PATTS) peculiar to the F100 engine that may portray any improvement in the provisioning process for support equipment?

Although a direct comparison between PATTS and the earlier pieces of SE cannot be made, there remain enough points of commonality for a general comparison. This research determined that provisioning procedures applied to PATTS did indeed portray an improvement in the provisioning process for support equipment for the F100 engine. The authors reemphasize the point that one may not assume all SE acquisitions are handled with the foresight involved in the

PATTS program. It is believed that there is a general trend for greater incorporation of Integrated Logistics Concepts in the SE arena. Diligence on the part of those responsible for SE acquisition must be demanded if the Air Force is to have dependable support systems.

Research Question Number Three

Are the current and existing regulations and directives adequate to insure support of support equipment when consolidated into the acquisition of a major weapon system?

From the analysis of available documentation and the comments of those personnel interviewed, the authors can conclude that the current and existing regulations and directives are in general adequate to insure support of support equipment when consolidated into the acquisition of a major weapon system. Due to the very nature of man, people sometimes have varying interpretations of those regulations and directives, thus actions often resulted in outcomes which were less than desired. This research was sometimes hampered by the myriad of regulations pertinent to the topic of SE acquisition resulting in much loss of continuity and clarity. These observations were shared by those interviewed. Also, there is an inherent deficiency in the Programming Checklist which does not allow the Item Manager to take into consideration follow-on end item acquisitions.

Research Question Number Four

What were the effects of improper provisioning of specific support equipment for the F100 engine (1) on the operational readiness of the weapon system (aircraft), and (2) on maintenance procedures and schedules for the F100 engine?

The very fact that the maintenance data for the SE was not available further highlights the general lack of consideration and logistics planning given to SE in the early stages of the F100 program. Should this very important research question have been answered, the authors believe definitive evidence could have been presented to further emphasize this point. Therefore, the authors must conclude that the attention given to maintenance data reporting was grossly deficient in these cases and provides additional support for the general conclusion of this thesis.

The authors conclude that SE, as exemplified by the SCS Tester and Engine Trim Box, was not given the proper logistic planning and support it required. One should not indict all SE acquisition processes, but the fact remains that these two pieces received such inadequate attention that the support costs, including the recurring provisioning efforts and down-time, could have conceivably been greater than the benefits derived. There is reason for hope in that the example of the PATTS acquisition process was much improved and hopefully does represent to some degree an overall improvement in SE acquisition today.

RECOMMENDATIONS

When making recommendations from a study of this type, it is quite easy to suggest that there needs to be greater emphasis in the acquisition of support equipment. The authors believe the following areas need to be emphasized and improved upon. A recent IG report agrees in some areas (6):

1. The AGERD/SERD quality must improve to include the best functional and physical descriptions of the item and its use. The Integrated Logistics Support (ILS) concepts should also seriously consider a detailed follow-up to insure the Item Manager, AGMC, and HQ AFLC have adequate opportunity for their particular inputs.

2. The IM must be made aware of follow-on acquisitions. He must be allowed to adequately provision for the necessary spare parts that additional items of SE will require. Therefore, the Programming Checklist should include the option for the IM to take future acquisitions of SE items into consideration.

3. Those judged competent in the management of SE should attend the provisioning conferences and be allowed an influential status. Personnel that should be included are the IM Technician, Equipment Specialist, and an AGMC Representative. Therefore, adequate TDY funding must be made available to allow these personnel proper planning opportunities for attendance.

4. As in the case of the PATTS acquisition, representatives from the Support Equipment Special Program Office (SESPO) should attend all planning conferences to assure quality inputs are made.

5. Maintenance data reporting for all complex SE should be made mandatory as early as possible after operational deployment. Timely data reporting would allow for maximum maintenance and supply supportability. In addition, detailed analyses of the type attempted in this research effort would be possible.

Recommendations for Further Study

The authors firmly believe statistical analyses of SE/Weapon System relationships of the type attempted in this study could lead to a more clear understanding of the role that SE (or the lack thereof) plays in operational readiness of a weapon system. Therefore, efforts should be pursued to analyze the acquisition of SE and its impact on respective weapon systems. This analysis should also include the various maintenance data reporting systems.

APPENDIX

INTERVIEW GUIDE (ACQUISITION)

EQUIPMENT: SCS, ETB, PATTS.

NAME: ______________________________ DATE: __________

POSITION, TITLE: ______________________________

LEVEL OF INVOLVEMENT: ______________________________

QUESTIONS:

1. Were all acquisition and provisioning steps accomplished according to the current directives?

2. If not, what was not accomplished, and why not?

3. Were there any extenuating circumstances involved in the initial conceptualization or acquisition of the support equipment (concurrency, etc.)?

4. Were these circumstances so extenuating as to possibly have caused supportability problems?

5. What do you see as the problem areas in the acquisition of this specific type of support equipment?

6. What suggestions do you have as possible remedies for those problems referenced in # 4 & # 5?

INTERVIEW GUIDE (MAINTENANCE)

EQUIPMENT: SCS, ETB.

NAME: ______________________________ DATE: ____________

POSITION, TITLE: ______________________________

LEVEL OF INVOLVEMENT: ______________________________

QUESTIONS:

1. In what area and level of maintenance were you involved?

2. Were adequate maintenance support procedures (repair parts, tech. orders, etc.) for the support equipment provided you?

3. If not, what were the shortcomings?

4. What effect did these shortcomings have on your ability to maintain the equipment?

5. What effect did these shortcomings have on maintenance of the F100 engine?

6. What suggestions do you have for improvement of the support for support equipment - specifically and in general?

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